THE MODEL ENGINEER

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The MODEL ENGINEER

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Our Cover Picture

● THE IMPRESSIVE photograph reproduced on our cover this week was taken by Mr. C. R. L. Coles, of the Kodak Recreation Society. It shows a Euston-Birmingham-Wolverhampton express climbing the Camden Bank out of Euston; the engine is one of the sprightly Class 5, 4-6-0 mixed-traffic type, No. 45418, and she appears to be well set for her journey. The Camden Bank, coming as it does immediately outside Euston station, is a formidable obstacle which makes the starting of heavy trains a difficult task for locomotives; it is probably the most awkward railway exit from London.

In these days of poor fuel, the Camden Bank often causes the locomotives to put up some heavy smoke-clouds which cannot be very popular with the local inhabitants! But, on the score that it is an ill wind that blows nobody any good, the place is a paradise for the photographer with an eye for effect.

Preserving Information

● THE ANNOUNCEMENT, published in our issue of June 8th, that the two old beam-engines at the works of Messrs. John Lean & Sons Ltd., Glasgow, are soon to be broken up calls attention once more, to a matter of some considerable importance. It is that everything possible should be done, in such cases, to preserve all recordable information as to the details of construction, and not to forget the dates of building and demolition.

Most unfortunately, the preservation of actual specimens of engineering skill is very seldom possible, owing to the space that would be required; but it *is* always possible to keep accurate notes as to constructional and other interesting features. Notes of dimensions, photographs of typical features, and records of all kinds may not seem to be of more than passing interest at the time they are made; but, in years to come, they will be invaluable.

In modern times, there is a very regrettable tendency to scoff at anything which is old and historical, on the grounds that it has served its purpose, has become "out-of-date" and, therefore, is better destroyed and forgotten. This attitude is responsible for many of the difficulties which face those of us who would attempt a reconstruction in miniature of some locomotive, ship or other engineering masterpiece. If only the records had been more complete and made more easily accessible, the difficulties of a succeeding generation of enthusiasts would be greatly minimised.

Queer Lathes

● HAVE YOU ever seen a left-handed lathe? No? Neither have we, but a print recently submitted by a reader clearly shows a lathe having the tailstock to the left, and the headstock to the right, viewed from the front or operating side. The features of the lathe, apart from this discrepancy, follow those of the well-known $3\frac{1}{2}$-in. Drummond or " M " type Myford lathe, and the print is a half-tone reproduction from an overseas magazine illustrating the training of engineering students in China. It is, of course, an axiom that the Oriental craftsman uses very different methods to those with which we are familiar, and many of his tools are different in design, and used in a different way; but we have never heard that this applies to metal turning lathes. In this country, tools are sometimes encountered which have been specially designed for the use of left-handed craftsmen; but never left-handed lathes! We think the explanation of this particular photograph is that it has been printed from the wrong side of the negative, either by accident, or by the instructions of an editor who was more concerned with artistic composition than technical accuracy.

By a curious coincidence, this photograph arrived at the same time as a cartoon was published in a daily paper, as the accompaniment to an article on " How to Avoid Work," which also showed a lathe as its main feature. In this case, the lathe was not of a recognisable type, which was natural in the circumstances, but apart from inaccuracies of detail, which might possibly be condoned on the grounds of artistic license, the remarkable thing about it was that it was being operated from the *back* by a vacuous-faced youth, who apparently had very little idea of manipulating anything except the tailstock barrel clamp lever—and couldn't care less, anyway!

" Mechanical Thinking "

● THE CAPTION under the above cartoon was to the effect that those who operate mechanical appliances get into the habit of " mechanical thinking," the inference being that the mental processes of the operator become as stereotyped as the motions of the machine. This is a common fallacy among those who do not have a practical understanding of mechanical craftsmanship; but even though it is quite true that some kinds of machine operations in repetition work call for little mental effort, that is surely no reason to infer that it should adversely affect the reasoning processes of the machine operator. All kinds of repetition work, whether using machines or not, involve a sequence of mechanical motions of the worker's limbs; but nobody reasons from this that the action of sewing a seam, hoeing a row of turnips, or pedalling a cycle is liable to lead to mental atrophy or degeneration. On the other hand, it can be reasoned that actions which make little demands on mental concentration, are more likely to set the mind free to pursue other, and possibly more constructive lines of thought. In the particular case which forms the subject of the cartoon, the lathe is not of the quantity production type, and as every " M.E." reader knows, success in the use of a centre-lathe demands a fair amount of intelligence, not to mention constant care and concentration on the work in hand. We are inclined to think that the operator addicted to " mechanical thinking " would be very unlikely to attain proficiency in turning, or any other type of craftsmanship that we know of.

Locomotives in Streets

● WE WERE very pleased to receive an interesting letter from Mr. John Peckett, joint managing director of the Bristol locomotive-building firm of Peckett & Sons Ltd., who writes :—

" I was very interested in your cover picture and accompanying article in your issue of May 25th showing a small 0-6-0 saddle tank locomotive drawing a train through the streets. I feel however, I should like to add to your article. You say that main line locomotives are not allowed in the streets. You did not make it clear that this is not because they are main line locomotives but because firstly they would not be able to negotiate the curves at Weymouth, Avonmouth or Southampton, etc., and secondly I do not for a moment consider the rails would be heavy enough for main line locomotives. Present day rolling stock, however, can traverse far sharper curves and run on far lighter rails than the modern 4-6-0 or 4-6-2 locomotives. With regard to the locomotive *Cwm Mawr* you illustrate, I believe this was built by the late Avonside Engine Works, Fishponds, Bristol, about 30 years ago. It has, however, been altered at some time or another, possibly at Swindon. The safety-valves are obviously G.W.R. design and are placed on top of the firebox with a corresponding hole in the saddle tank instead of the " Cowburn " type which the Avonside people used to fit on the dome cover. Their practice was to fit the regulator on the smokebox tubeplate but it is now apparently fitted in the dome owing to the lubricator for the regulator being fitted on top of the brass dome cover in accordance with G.W.R. practice."

Cars or Caricatures?

● A LAMENTABLE state which at present exists among the model car building and racing fraternity is their apparent lack of knowledge relative to design and general details of full-size practice.

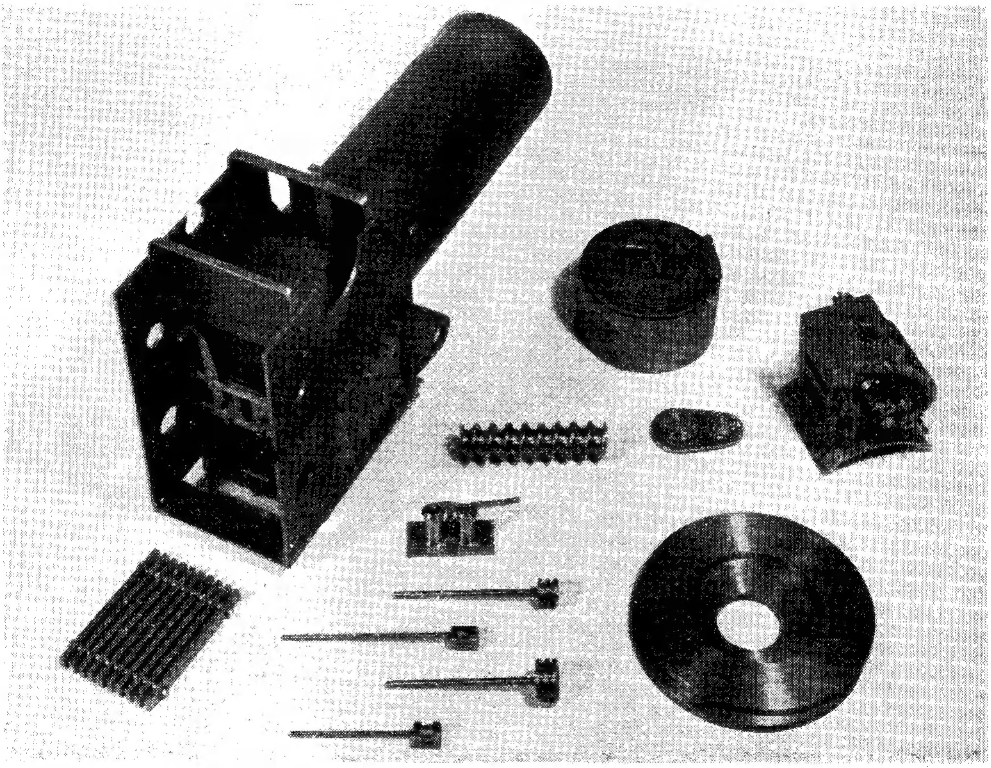
Now, as lack of knowledge is more often than not an outcome of lack of interest, it can only be assumed that the majority of the " exponents " have no desire whatever to construct a model of any known motor car, or even a caricature of such an object; their sole idea is speed, like a child with a new tricycle, and they use the word " car " purely as a convenience.

Why not follow the examples of the locomotive and ship modellers who, though deeply interested in performance, construct their magnificent models *to scale*, with rigid attention to detail. To achieve this end means fascinating hours spent in pursuit of information which, in most cases, will lead you to someone's racing stable and further, and newer interests. In other words, cultivate the prototype habit and the sport of miniature motor racing will come into line with all the other things that are best in Britain.

A $1\frac{1}{2}$-in. Scale "Burrell" in the Making

by C.G.S.B.

THE accompanying photographs will, it is hoped, interest fellow traction engine enthusiasts, and in particular those who are building a similar machine. It is a $1\frac{1}{2}$-in. scale "Burrell" single crank compound. Excellent fully detailed blueprints and castings are supplied by Mr. A. J. Every of Ealing, W.13. The parts call for little comment, but the following notes may be of interest.



Boiler No. 2. smokebox ; cylinder block ; pistons ; valves, etc.

Boiler

This is the heart and foundation, as not only does it provide the power, but upon it the whole machine is built. It must be sound and efficient from a "boiler" point of view, and must also hold up closely to the nominal dimensions to ensure proper alignment of the motion and transmission gear. Having had no experience at boiler making but plenty at brazing during apprenticeship days, a start was made meanwhile on the horn plates ; at the same time an intensive course of study of earlier articles by your esteemed contributor "L.B.S.C." was undertaken during the evenings. After about four weeks it was decided that the boiler could be successfully fabricated, and here grateful acknowledgments are humbly tendered to "L.B.S.C." for his lucid and practical instructions—what a pity he cannot be persuaded to drop locomotives for a bit and build a traction engine. It would be right up his street. He could put flanged wheels on it and run it round the Polar route !

Firebox was tackled first, and three were made before a satisfactory one was produced. All the holes were drilled in the wrapper plate for the firebox stays before assembly to achieve, as was thought, greater accuracy for the attachment of the horn plates. This was a mistake. They did *not* register with the horn plates already made. So Boiler No. 1 was scrap on the last lap.

Boiler No. 2 (illustrated) was plain sailing after all this experience, and rapidly completed and tested to 150 lb. per sq. in. hydraulic. It was brazed throughout except firebox stays.

The design calls for six extended 5/32 in. firebox stays on which to attach the horn plates. This was not satisfactory as a 5/32 in. thread in a 16-gauge copper plate was inadequate to secure a firm fixing. The thread stripped and the stays started to pull the fire box in. These stays were therefore replaced with hollow stays of $\frac{3}{16}$ in. P.B. rod drilled 5/32 in. and sweated into position. 5/32 in. steel bolts were put through with heads in firebox and well and firmly nutted down outside. Subsequent tightening when in service will tend to strengthen the staying and not weaken it.

Horn Plates

Great care was taken to ensure the accurate location of the three holes for the shaft centres so that the gears would mesh accurately. The plates were bolted together with a thin piece of wood in between and the shaft centres positioned with tool makers' buttons and slip gauges (some home-made for the job). As the lathe would not swing them they were bolted to an angle-plate on the saddle, and each button in turn set true with dial indicator attached to chuck face. Boring tool mounted in a 4-jaw chuck, gave sufficient adjustment for putting a cut on after the holes had been rough drilled. The larger hole for the crankshaft bearing in r.h. plate was bored at the same setting ; hence the reason for the piece of wood interposed between them.

Crankshaft

This was an interesting piece of machining. The design calls for a shaft forged out of $\frac{7}{16}$ in. round material with $\frac{3}{8}$ in. journals. This was not practical. Mr. Every advised nicking, bending and brazing. This was tried, but did not look good, so the shaft was just machined out a of flat piece of bar in the usual fashion and the webs rounded with a file.

The driving end is finished with 8 integral splines ; a bit of draughtsmanship and simple maths. decided that splines 3/64 in. deep and 0.0577 in. wide at root, would have a well-proportioned appearance. (There is a lot in the rough rule of early engineers, " if a thing looks right it is right.") This made the root 9/32 in.

A tool for gashing out the spines in gear blanks in the lathe was made 0.0577 in. wide, also an end mill of the same diameter, but on the minus side, for first operation on shaft end. A piece of silver-steel was turned to a $22\frac{1}{2}$ deg. included angle, this to make sides of splines parallel. The small end was left on the *small* side, as it was impossible to accurately mike this to 0.0577 in. Four flats were then filed to produce 4 cutting edges on the pattern of a broach and stoned up to a keen edge after hardening. These tools are shown lying in front of crankshaft.

A piece of mild-steel $\frac{1}{2}$ in. diameter for a test piece was machined for part of its length to $\frac{3}{8}$ in. diameter with about $\frac{1}{4}$ in. at its end reduced to the root diameter of 9/32 in. The 8 slots were then milled until they just touched the root diameter with above-mentioned end mill of 0.0577 in. diameter bare. The taper mill-cum-broach was then passed along these milled slots at high speed and flooded with coolant and produced a perfect finish. When the mill bottomed, it would not cut any more. The small end was stoned off a little and a further cut taken ; ditto, until the root of the spline was exactly to size, using the gashing out tool for gear blanks as gauge.

As the test piece looked good the same process was gone through on a piece of silver-steel $\frac{3}{8}$ in. diameter with a fairly long 9/32 in. spigot each end. (The top spigot broke off in use so is not visible.) This was grooved and formed into a drift tempered to dark straw for finally sizing the gear blanks.

A test gear blank was bored 9/32 in. gashed with the first mentioned tool, and then sized with the drift using drill press as such—with apologies to all engineers ! Several passes of the drift were made in different positions to equalise out any minute errors in dividing head. It was found to be a tight push fit on the splined test piece ; about a couple more thou. were therefore stoned off the end of the taper mill, and it passed once more along the test piece. This removed a mere scrape from the sides of the splines and resulted in a perfect sliding fit in any position.

The end of the crankshaft was now milled using the same set up, operations, and mike dial settings, as on the test piece. As the shaft was so much longer and more slender than the test piece it was supported directly under the part being splined with a V-block and packing to prevent any spring under the cut.

The test piece was later threaded on the spigot end and used as a mandrel for finally sizing the gear blanks and milling the gear teeth.

The two valve eccentrics were machined and the keyway cut from one piece of mild-steel of sufficient length to allow them to be parted in two after finishing. Parted, faced off to width, one reversed and both pressed on to common feather key in shaft. (Drill press again for this job.) This ensures them being identical in diameter, throw, and angle of advance.

Differential Gear

As no ready means of setting dividing head on milling machine at appropriate angle could be thought of the blanks were mounted on turned spigot in lathe chuck, and teeth planed with top slide set over to appropriate angle. Wheel blanks were machined to $24\frac{1}{2}$ deg. angle and slide put to $21\frac{1}{2}$ deg. angle for cutting the teeth. Pinions were machined to $68\frac{1}{2}$ deg. angle and cut at $65\frac{1}{2}$ deg. This was to make teeth deeper at large diameter. Surprisingly enough they meshed together perfectly, straight off the tool without any easing with a file and ran smoothly ; but the same method would probably not do where high revs. are to be coped with. Cutting the teeth was a pretty tedious job as only a thou. cut could be taken, and winding the cross-slide to and fro 80 time plus some (depth of tooth being 80 thou. as 28 d.p.), gave production time on each wheel of nearly 12 hr. and pinions in proportion. It would be better to rig up a temporary lever feed to the cross-slide.

Spiral drum for steering chain is 1 in. diameter steel $2\frac{1}{2}$ t.p.i. This was too heavy a load for 8 t.p.i. leadscrew even in lowest back gear, but it was found that by slight manual assistance by

winding handle at its end the cutting proceeded quite well. This drive from both ends may have produced slight pitch errors, but they cannot be detected with the eye, and in any case are not material on this job. The blank was roughed-out with various stock screw cutting, knife and parting tools and finally sized with form tools. One for the root and flanks and another for the crown.

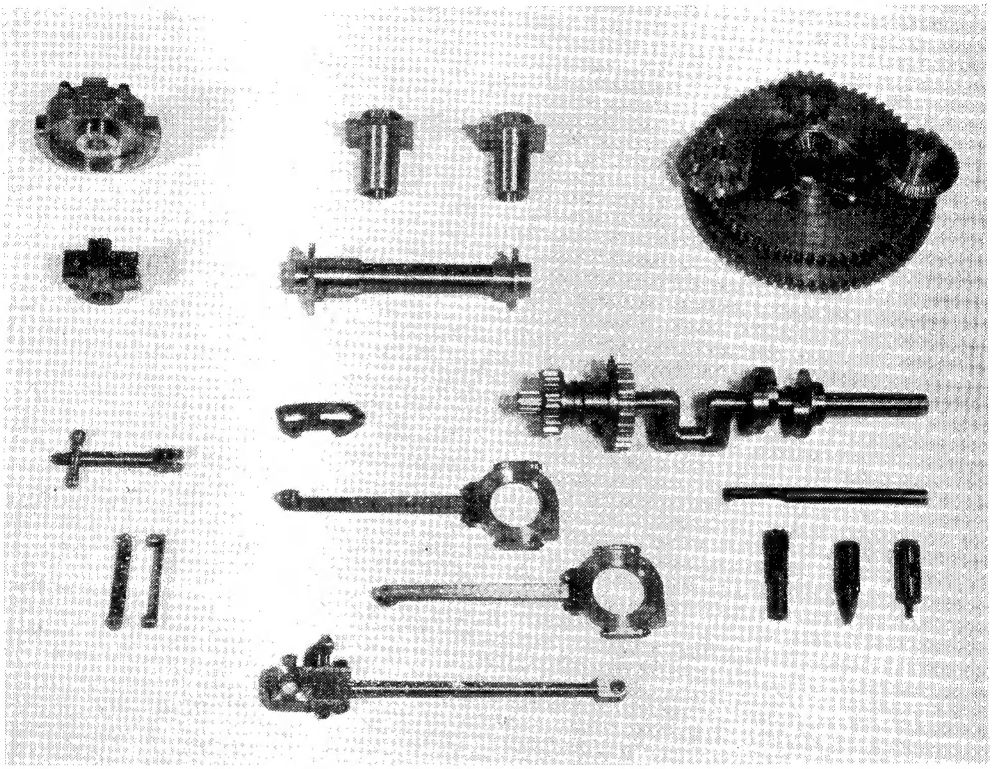
The safety valve is built up from rod and plate phosphor bronze and brazed. The actual valve is in one pillar, the other and the trip lever are dummy.

Smokebox is steel, and door and ring cast-iron. Off-cuts of steam tubing in almost any size can be obtained from any local hot water engineer for a nominal sum, and it machines just like good mild-steel. A piece long enough to make two smokeboxes as shown, plus chucking piece cost sixpence.

The two large blanks are for main gear wheels and are from punchings of $\frac{3}{8}$ in. boiler plate, obtained from the scrap heap at an engineering works. They machine beautifully. It was found that blanks of this size cut from bar cost 7s. each, so something had to be done about it. A dozen were collected, so five pairs remain in stock, and a pair will be gladly sent to any fellow builder if he will pay postage.

Workshop equipment consists of a "Little John" lathe, bought about two years ago. An excellent tool with many good features. Hollow spindle to take 1 in. clear. Infinitely variable drive, most useful when facing. The Timken roller bearing headstock is quite satisfactory. It has its faults, but is good value for the price, and the perfect lathe has yet to be made.

A very early Drummond with central leadscrew, bought second hand in 1920 for £5; up to two years ago it was my only lathe, and treadle-driven at that. The arrival of the second lathe enabled a complete rebuild of the Drummond to be tackled. A new and larger mandrel was fitted with double cone cast-iron bearings, $\frac{5}{8}$ in. clear hole and nose to take standard collets up to $\frac{1}{2}$ in. capacity, and usual chucks. New spindle to tailstock 1-in. diameter to take No. 2 M.T. centre. All slides were rescraped and micrometer dials fitted to cross-slide, leadscrew and tailstock barrel. This last is really useful for accurately depthing holes, direct drive for traversing feed through Sturmey Archer 3-speed cycle hub and automatic knock off with micrometer adjustment, motorised with $\frac{1}{4}$ h.p. motor, 12 spindle speeds, maximum 1,850 r.p.m. It now produces small work, such as 10-B.A. bolts with speed and precision, and is used for all fine work.



The differential gear opened up; crankshaft and gears; connecting-rod; valve motion parts; crank; second shaft and main shaft bearings, etc.

Tom Senior M.1. milling machine with vertical milling attachment, dividing head and rotary table. This machine is a perfect joy to use. The automatic traverse is a bit fast for model work, but Mr. Senior is making another pair of sprockets to reduce feeds by about half.

The dirty shop contains brazing hearth equipped with Calor gas and torch supplied by Spensers Ltd. This gives a powerful clean flame without any separate air supply adequate for all ordinary boiler work and is economical. One cylinder of gas has been in use for six months, made the two mentioned boilers, tools and numerous other jobs, and shows no sign of giving out. A second full cylinder is connected up to switch over to in case of failure of supply in the middle of a job.

There is a point to be watched when using a large torch such as this. As the consumption is high, the rapid evaporation of the fluid cools the cylinder and the pressure falls. Actually at normal temperatures the pressure remains constant at 28 lb. per sq. in. until cylinder is empty. A small electric heater placed against cylinder, takes care of this, or switch over to the second cylinder and allow first to warm up again. Some operators, it is said, turn the torch on to the cylinder, but this is not recommended by the Calor people!

Since the installation of this outfit, five pint blowlamps, and the like have become museum pieces.

Detached Note

Inner and outer rings of old ball-bearings make excellent packing-pieces for miller or lathe. They are hardened and dead true to size, e.g. for facing gear blanks. Face one side, reverse in chuck with suitable ring behind blank, hold in position with tailstock barrel against face of chuck and tighten chuck jaws. Result, dead true disc. Any garage will supply for a nominal sum and it is easy to knock out the cages and balls.

Another Detached Piece

In making rivet snaps or bolsters by the usual method of biffing the end with a steel ball, if the ball is selected twice the diameter of the rivet shank a perfect head is produced. For $\frac{1}{16}$ in. rivets use $\frac{1}{8}$ in. ball, 3/32 in. rivets $\frac{3}{16}$ in. ball, $\frac{1}{8}$ in. rivets $\frac{1}{4}$ in. ball, and so on.

For the Bookshelf

The Gresley Pacifics of the L.N.E.R., by Cecil J. Allen. (London: Ian Allan Ltd.) 128 pages, size 5 in. by $7\frac{1}{2}$ in. Illustrated. Price 8s. 6d. net.

To a very large number of locomotive enthusiasts, the Gresley Pacifics of the London and North Eastern Railway were, and still are, immensely popular. A considerable amount of ink and space in periodicals and books has been devoted to the story of the design, construction and working of these remarkable engines. To the general public, too, the engines possessed a glamour and fascination, due largely to the publicity that has always been accorded them, and there might be some grounds for the belief that nothing new could be said or written about them.

But Mr. C. J. Allen has here given us a new and extremely pleasing book which, although it must inevitably cover a certain amount of familiar ground, contains much that is more personal and, therefore, new. Moreover, it does bring together in a handy little volume a remarkably complete history of one of Britain's most admired locomotive types.

The illustrations, apart from the official photographs and diagrams, are a joy; they have obviously been chosen with a view to preserving as thrilling a pictorial record as possible of the work accomplished by the Gresley Pacifics when they were in their prime. It would be difficult, indeed, to make a more attractive or appropriate selection of photographs for illustrating a book of this kind.

As to the text, Mr. Allen is so well known and so competent a writer as to need no commendation from us; suffice it that the reader need not be a Gresley enthusiast to enjoy every page of this book.

Mechanics for the Home Student, by E. N. Simons (in association with W. D. Burnet.) (London: Iliffe & Sons Ltd., Dorset House, Stamford Street, S.E.1.) Price 7s. 6d.

In this book the author sets out to explain the principles of mechanics in simple language, using practical and homely examples to illustrate basical physical laws and their effects. It is intended particularly for students who are unable to attend organised classes or instruction courses, but have to study at home, without the aid of the counsel or verbal explanations of a teacher. The chapters deal with the laws of motion, applied to gases, liquids and solids, definitions of force and power, basic principles of structures and machanism, and properties of materials.

Newnes' Short-wave Manual, (Seventh edition.) by F. J. Camm. (London: George Newnes Ltd, Tower House, Southampton Street, W.C.2.) Price 6s.

In the latest edition of this well-known book, the subject matter has been revised to conform with up-to-date knowledge of electronic science, and the book now contains 200 pages, with nearly 100 illustrations, mostly in the form of line drawings, and also miscellaneous information, such as international call signs and world short-wave stations.

Model Car Racing in the U.S.A.

by Howard W. Frank

THE hobby of racing miniature cars is engaged in by some 3,000 enthusiasts at approximately 300 specially built tracks throughout the United States. The sport is strictly on an amateur basis with rules set up by two associations, namely the International Model Race Car Association and the American Miniature Racing Car Association. Race meets are run under sanction by either group.

The I.M.R.C.A. recognises record speed at the quarter mile distances only, and the A.M.R.C.A. recognises quarters, half, and one mile distance records. I.M.R.C.A. has four classes of cars—spur gear, custom prototype, manufactured prototype, and Hot Rod, whereas A.M.R.C.A. has only two classes, spur gear and prototype.

Howard W. Frank with some of the 92 trophies won during four years of model car racing. The car in his hands is an experimental spur-gear stream-liner, powered with a Dooling engine

Each association sanctions some thirty or forty meetings during the racing season, plus regional meetings, and the one big meeting per year, either the Nationals or the Internationals. At the local meetings there are from 50 to 70 entries with as many as 135 cars showing up at the big yearly events.

Recognised records as at the end of 1949 are as follows :—

I.M.R.C.A. (¼ mile)	m.p.h.	A.M.R.C.A. (¼ mile)	m.p.h.
Spur gear	138.88	Spur gear	141.06
Custom proto.	138.88	Prototype	140.62
Mfg'd. proto.	130.81		
Hot Rod	114.21		

In running a meeting each car is allowed two or three heats, the best time to count as official. Trophies are awarded to the winners on a basis of one trophy for each three entries in each class.

Official timing is done with electric clocks which are read to 1/100th of a sec. Operation of the clocks is automatic being actuated by a micro switch, located at the centre pole. Each operator is allowed three minutes to make an official run.

Official cable track sizes are 1/24th of a mile, 35 ft. cable using 0.046 in. semi-tempered music wire; 1/20th of a mile, 42 ft. cable (0.042 in. wire) ; $\frac{1}{16}$th of a mile, 52½ ft. cable (0.037 in. wire). All cables are made to allow for a 9 in. bridle measured from the centre line of the car. Tracks must be suitably fenced in and equipped with crash walls.

There are about a dozen so called rail tracks of either a 1/12th or 1/16th of a mile distance, which are banked ovals on which from four to six cars can operate at the same time. All races are run from a standing start. Each car is equipped with ball bearing adapters which will ride on individual steel rails, keeping the car on its course. Rail tracks cost $8,000 to $10,000 to build. Cable tracks of cement vary from $500 to $1,000. The present track record is 108.69 m.p.h.

Prototype cars are built to resemble actua racing cars, the chassis being cast of aluminium with shaped balsa wood bodies, or of formed plastics. Motor drive is through bevel gears only, with gear ratios of 1.5 to 1 ; 1.84 to 1, and the most common 2 to 1. Prototype cars must ride with all four wheels touching the track. Custom prototypes are those built up by the individual and manufactured prototypes are those purchased from a manufacturer with certain changes allowed by the individual, such as change in gears, tank, wheels and tyres.

Spur gear cars are shaped like streamlined flat teardrops, with the motor located ahead of the front wheels. They are driven through spur gears usually with a gear ratio of 1.75 to 1. Spur cars may ride with only the inside wheels in contact with the track surface. They are usually made from cast aluminium, both top and bottom, and have a weight of about 6 to 6½ lb.

Hot Rod cars are modelled after the California type stock car, may be either bevel or spur geared, but the motor must be situated between the axles.

The prototype cars weigh from 5 to 6½ lb. Regardless of class, all moving parts are mounted in ball bearings to reduce friction. The fastest prototypes are rear wheel drive ; clutches are

not used. Springing is only done on the idler axle, and may be either rubber mounted or built up from spring steel.

Fuel tanks are built to counteract the great centrifugal forces applied to cable racing, and will hold from four to five ounces of fuel. Tanks are usually built with an air ramming tube projecting forward so as to pressurise the tank.

The faster cars are equipped with regular ignition systems rather than glow-plug operation as more power is developed with a properly timed ignition system. An extension wire out of the switch is installed so as to turn off the car after its run.

Since the use of " hot " fuels, it has also been necessary to install fuel shut-off valves between the tank and the carburettor, the valve being connected by some means with the ignition switch, so that when the car is "flagged" down both the ignition and the fuel will be shut off.

All of the present high speed cars have a wheelbase of 10 in. to 11 in., and wheel tread of about 6 in. Average length of cars is 18 in. from tip to tip.

Wheels are made in two halves, which grip the semi-pneumatic rubber tyres. Tyres are manufactured with a diameter of 4 in., and can be secured in hard, medium and soft grades. The width of the tyre tread varies from $\frac{1}{4}$ in. to $\frac{7}{16}$ in. The selection of tyre grade and size depends on the type of car and the gear ratio used.

Bridle attachments are adjusted so that the car is in perfect balance fore and aft with battery and fuel included. The height of bridle posts is varied to get proper ride on the track ; most cables are from $1\frac{1}{2}$ in. to 3 in. higher at the centre pole than the track surface. Toe-in is not given to the wheels.

Engines

Although other sizes of engines are recognised and becoming popular in the U.S.A., the major class engine used is one of 10 c.c. piston displacement. The most popular commercial engines are the Dooling " 61," the McCoy series " 20," and the Hornet (out of production). The Dooling engine, which at present holds all the major speed records has a stroke of 0.750 in. and a bore of 1.015 in., and it develops $1\frac{1}{4}$ h.p. at 15,500 r.p.m. The greater majority of racers use commercial engines and modify them for higher performance.

In modifying a stock engine, the main principle followed is to reduce friction to a minimum, and to allow as much fuel mixture as possible to enter the engine. This means that all moving parts are checked for proper fit and clearance. Polishing of the internal parts to enable a smooth fuel flow is also done.

Reporting of liners or rotor disc valves is rarely done, but all square edges of ports are rounded off enabling the mixture to flow smoother. Carburettor venturi is sometimes rebored oversized from 0.020 in. to 0.040 in. from the standard of $\frac{3}{8}$ in. size. Rotor disc valves are checked for smooth rubbing surfaces and reduced friction in the bearing.

Many operators increase their compression ratio by removing 0.010 in. from the cylinder head although some engines have been known to come from the factory with high compression heads already installed. Increasing compression can be critical as it will add to the heat developed and can only be successful if done by tests.

During 1949, a noticeable gain in speed was made by the installation of chrome-plated cylinder liners, and holding of piston clearance to 0.0026 in. to 0.0028 in. Ring friction is reduced with chrome liners, and the liner tends to hold its round shape longer.

Most of the faster cars are ignition timed at 0.198 in. to 0.205 in. before top centre. Timing is done with dial indicators and checked frequently. Point gap setting is 0.004 in. to 0.006 in., and spark plugs are set at 0.014 in. to 0.016 in.

In general may I say, an engine will give higher speed and more power when there is less friction, and when more fuel can be " sucked in."

Fuel Mixtures

The basic fuel and the fuel mixture used for breaking in new motors is 25 per cent. castor oil and 75 per cent. methanol (methyl alcohol). All basic fuel mixtures start out with the 25 per cent. castor oil, and the remaining 75 per cent. of the mixture will be changed to suit racing conditions. If an additive of some sort is used the castor content is never changed ; some additives which will increase speed are 5 per cent. amyl acetate, or 5 per cent. nitrobenzine (Oil of Mirbane), or even 5 per cent. motor ether (only in cold climates). If adding any of the above chemicals, then we would still have 70 per cent. methanol.

It has been found that the use of nitromethane in a fuel mixture has been the greatest benefit for increasing speed. Since nitromethane has its own oxygen element, greater power is developed, but higher racing temperature is also apparent. It is necessary that the car be equipped with a fuel shut-off valve as "after burning" will take place when using nitros and turning off the ignition will not stop the engine from running.

A typical fast and hot fuel used in the U.S.A. is made up of 25 per cent. castor oil, 25 per cent. nitromethane, and 50 per cent. methanol. Many fast cars are able to operate with as high as 50 per cent. nitromethane, but only the most experienced operator would dare go this high, because of the likelihood of burning up the motor.

Since competition in the U.S.A. is so keen, fuel mixtures can be the difference between winning a race, and coming in far behind the trophy-awarding brackets. An example of close speeds was shown at the National race held in Indianapolis in August, 1949. In the prototype class the winner did 138.10 m.p.h., the 20th car did 132.15 m.p.h., and the 45th car did 129.89 m.p.h.

Development of fuels will continue during the coming years ; basically the idea is to find as hot a mixture which will not burn up a motor. There is plenty of room for experimenting, since the use of rocket fuels became known, but on the other hand the rebuilding of a burnt up motor can be expensive.

Running the Race Cars

For a model race car to win races it must be

(*Continued on page* 900)

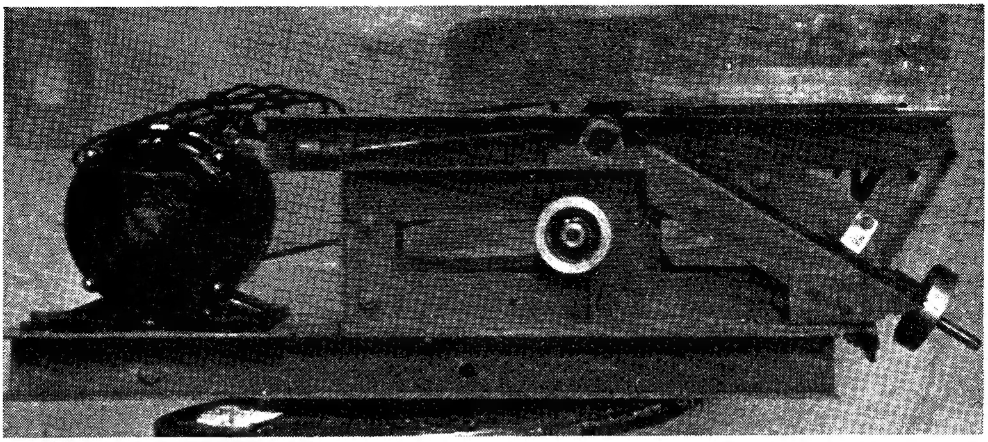


Photo A. Showing working side of machine for operator. Chromed index finger shown near bottom of slide

A Wood-Planing Machine from Scrap

by J. E. Peart

THE accompanying photographs show several aspects of a wood-planing machine which, with the exception of the $\frac{1}{2}$ h.p. motor and the cutter block, I made entirely from scrap.

It will be seen that the material employed is mainly $1\frac{1}{2}$ in. angled steel with a base of 2 in. channel, and assembly has been effected entirely by bolts and nuts.

Upon installation, the machine was mounted on a sliding base, which allows it to be retracted under a bench when not in use. A folding stand supports the machine under working conditions, but is not shown in the photographs.

The cutter block, $4\frac{1}{2}$ in. by $1\frac{1}{2}$ in. is mounted in 1-in. phosphor-bronze bearings, pressed into aluminium housings, and runs at 2,600 r.p.m. The drive is transmitted *via* belt and fixed pulley, with an idle pulley running on a ball-race, lubrication of which is afforded through a hole drilled and tapped in the outer plate, photograph " B," to take a grease cup or gun. Lubrication of the cutter block bearings is through copper tubes

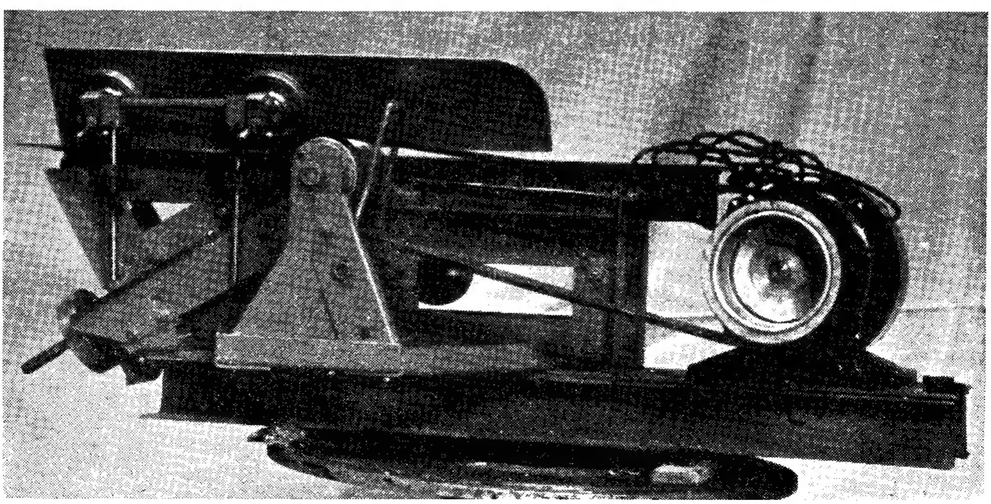


Photo B. Showing driving side with extension bracket for pulleys, also mechanism for operating adjustable fence

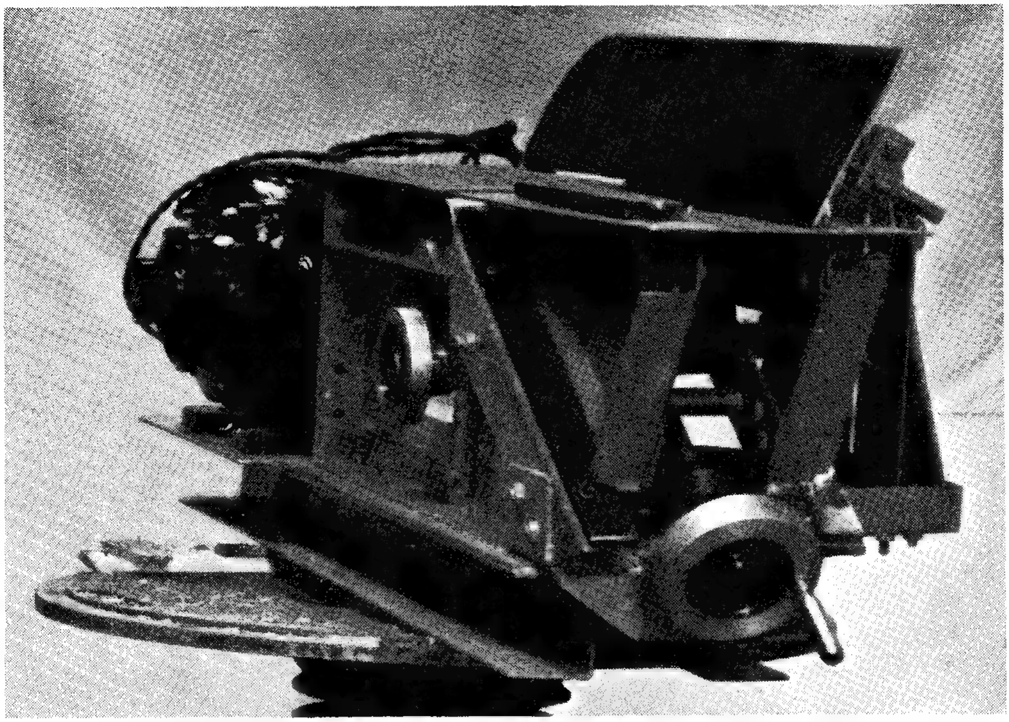


Photo C. Showing three-quarter view, giving a more sturdy and massive idea of construction

from screw-down grease cups, seen just in front of motor, in photograph "B."

The belt is controlled by a wheel, visible at centre in photograph "A," which is connected to a steel bar sliding in a tube of similar material. The table of the motor is slotted for belt tensioning adjustments.

Raising and lowering of the table is by hand wheel, clearly visible in photographs "A" and "C," and adjustment is gauged by a chromed index finger moving over a graduated scale.

The following dimensions should serve to bolster the above brief account and enable readers to form a clear idea as to the actual size of the machine :—

Length overall	..	3 ft. 6 in.
Height ,,	..	1 ft. 7 in.
Width ,,	..	1 ft. 7 in.
Length of tables	..	1 ft. 1 in. and 1 ft. [illegible] in.
Width ,, ,,	..	6½ in. ($\frac{1}{16}$ in. steel plate)

A fully adjustable fence is fitted.

Model Car Racing in the U.S.A.

(*Continued from page* 898)

kept in perfect condition, oiled regularly, checked before every race, and in general worked on like a fine watch.

It is suggested that complete records of data be maintained after each trial, so that if any change in speed is noted, the operator will know whether it was his tyres, his fuel, or the settings on his motor.

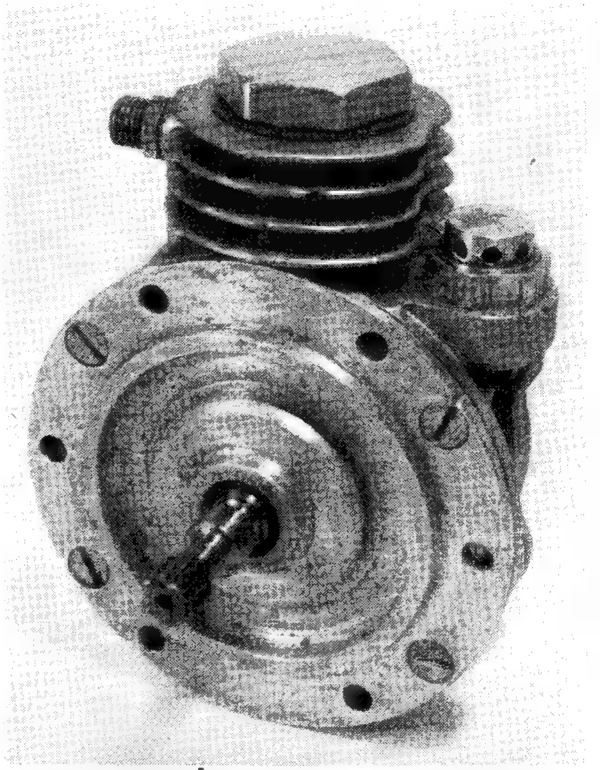
Wires should always be checked, batteries should always be "charged." Most American cars are equipped with 4½-V battery systems made up from nine pencell batteries soldered together. A charger battery of 6 V is hooked up to the car battery in *parallel* with a 2½-V bulb in the circuit on one lead. It will be noticed that the bulb will go out gradually denoting that the car battery is then fully "charged." Some operators can go through an entire year of racing with one battery pack by keeping it charged as above before every run made with the car.

In America the usual method for starting the car off on its run, is, first the car is warmed up for only a few seconds by placing the drive wheels on a motor driven wooden pulley. As soon as the engine starts to run, the switch is turned off so that the engine will not run freely and possibly throw the tyres off the wheels. The car is then hooked up to the cable, and a push stick used to start the car on its way. As the car is pushed off, a man at the centre pole will swing the cable until the car is running under its own power ; the centre man then jumps up on the platform above the cable where he remains until the run is completed.

Government Surplus
Piston-Type Compressors

by "Siskin"

MANY readers will have seen and handled the aircraft type compressors on the surplus market, and wondered about their utility in the amateur's workshop. It is hoped that this article will throw some light on the subject, about which authentic information is not easily obtained. Although two specific types are about to be described, it is not expected that readers will come across government surplus piston-type compressors that differ much from these types now on the market, unless perhaps they be of American origin.



BTH type A.V. compressor

The photograph shows a BTH type A.V. compressor as obtainable on the market. This type has a delivery of 0.368 c.f.m. and should charge a 400 cu. in. cylinder to 200 lb. per sq. in. in ten minutes at 1,200 r.p.m. It has a bore of 1 in. and a stroke of 1⅛ in., utilises crankcase compression, and the delivery pressure can be adjusted over a wide range up to 200 lb. per sq. in. Some models will pump up to 300 lb. per sq. in. Fig. 1 shows a section (not to scale) of the "business end" of this compressor, the principle of operation being as follows: As the piston ascends, air enters via the inlet valve *A* to balance the depression in the crankcase—hence the need for a sealed crankcase. The piston then descends, and at the bottom of its stroke, this air in the crankcase is displaced via the transfer ports *B* into the cylinder. On the next stroke, the ascending piston compresses this air until the delivery ball valve *C* is forced open, allowing the air to pass through into the cylinder head and thence to the delivery union *E* via ports *D* in the valve assembly retaining nut and the annular clearance space between the cylinder cap nut and the body casting. Here, let the unwary be reminded that this cylinder cap nut is "loaded" to the pressure in the receiver, therefore release the pressure before removing this nut to gain access to the delivery valve.

It might not be out of place if here the writer relates a true story with a moral. A young but keen rigger was dismantling an aircraft tail wheel of the "detachable hub" type which was held together by three high tensile steel bolts and nuts. The writer walked into the repair bay at the crucial moment to hear the bang and to see the unfortunate lad receive half the hub square in the face. Need more be said? Experience is oft a bitter thing!

Referring again to Fig. 1, it will be seen that the delivery ball valve *C* is seated within a larger conically seated valve *F*. This is the pressure regulating, or relief valve, with its spring *J* and adjusting nut *H*. When the receiver pressure balances the pressure of the valve spring *J*, the relief valve *F* is lifted from its seating in a downward direction: note that no air from the cylinder head is discharged into the cylinder because the delivery ball valve *C* is held hard on its seating within the valve *F* and seals the only communication passage between the cylinder bore and the head.

All the time the relief valve is held open, the piston strokes transfer the air from the crankcase to the cylinder and thence via the open valve *F* to an annular space *L* behind its head, where radial ports and a collector ring disperse it into the by-pass passage *G* back to the crankcase.

This "idling" or "unloaded" state continues until air is drawn from the pressure side of the system, when the lowered pressure allows the spring *J* to take over and close the valve *F*, and the compressor once more discharges its duty.

The delivery pressure can be adjusted by removing the split pin in the hexagon nut *H*, which is revealed by removing the cylinder cap nut and tightening or slackening the nut to raise or lower the pressure. It is probable that for really low pressures, a new and lighter spring may be found advisable, and a relief valve should be fitted to the air receiver, if only to allow for the remote possibility of the valve *F* seizing.

Other points of interest are as follows: the bronze cylinder liner projects into the crankcase and the piston is not fitted with rings but with oil grooves. Earlier models were fitted with cast-iron pistons and later ones, steel. This compressor utilises a "Scotch" or sliding crank in place of the more normal connecting-rod, and the upper half of the crosshead is integral with the piston. The lower half is detachable and carries a "tail" which dips into the crankcase oil for general lubrication. The crankshaft runs in ball-bearings, and the drive-end bearing is provided with some form of sealing device, while the other bearing is "blind."

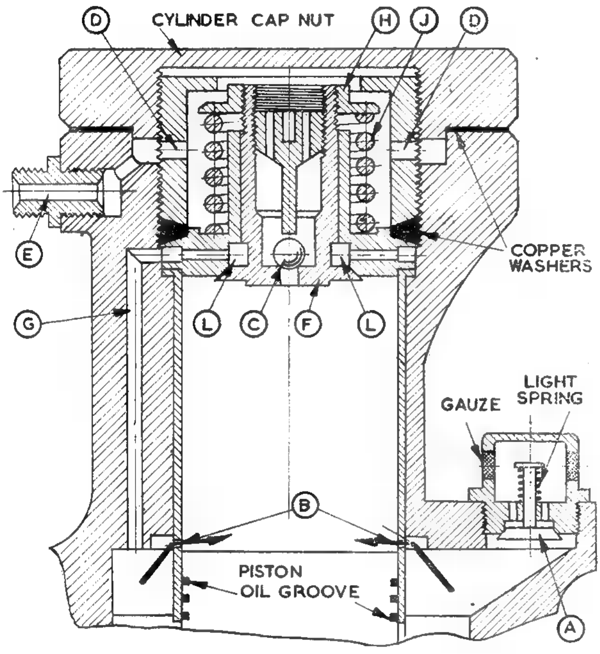


Fig. 1. *Sectional view of BTH compressor cylinder (not to scale)*

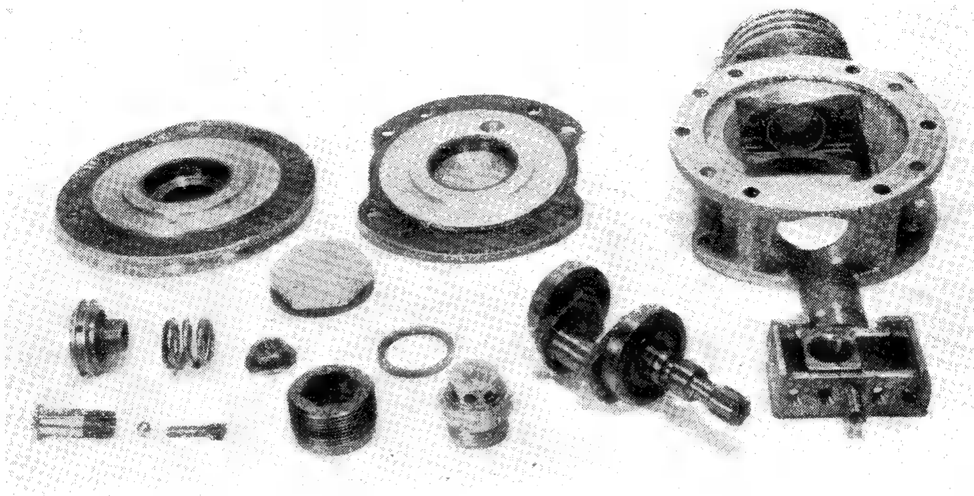
N.B. Since these bearings are designed for a purely torsional drive, it is essential that an outrigger bearing be provided when using the conventional pulley drive to remove all possibility of axial load on the bearings.

The reduced diameter at the driving end of the crankshaft close to the splines is a safety "shear" portion to prevent damage to the aero-engine drive to the compressor, in the event of the latter seizing. Some compressors of this type carry a pinion on the crankshaft. In aircraft use, this was intended to drive an engine speed indicator. A castor-base oil is used for lubrication, and the crankcase should be topped-up daily when the compressor is in use. The oil is introduced through the air inlet valve orifice after removal of the valve assembly. A spring-loaded oil level valve is housed in the anti-drive crankcase cover and its plunger should be depressed during the "topping-up" operation, until oil overflows from the valve, allowing any surplus to drain off.

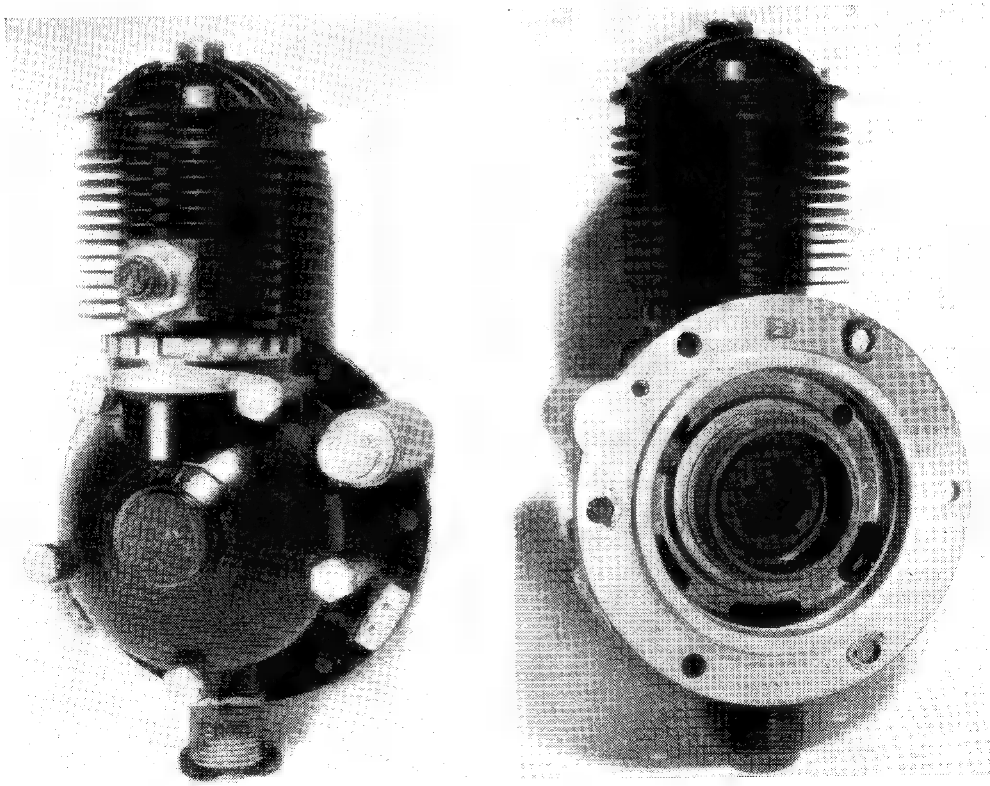
In aircraft systems, an oil bottle is placed in circuit between the compressor and the main air cylinder (air reservoir) the air entering the bottle from the bottom and passing through the oil. When the compressor relief valve is open and there is any tendency for the delivery ball valve *C* to leak, oil from this bottle leaks back round the ball forming an oil seal. This bottle is popularly termed the "oil seal."

The dismantling procedure for this compressor is quite straightforward. Remove the cylinder cap nut first, while the complete crankcase can be held in the vice—with suitable protection on the vice jaws. When both crankcase covers have been removed, access to the nuts and their lock-washers securing the crosshead assembly is obtained by swivelling the crosshead about the vertical centre line of the piston.

For continuous running at 200 lb. per sq. in., a $\frac{1}{4}$ h.p. motor is considered advisable, with corresponding lower h.p. when lower pressures are used, though this compressor will not deliver sufficient air to supply the larger commercial spray guns. Since very few model engineers are likely to want air at 200 lb. per sq. in. in their workshops, the pressure can be reduced to a more reasonable figure with less wear and tear on the motor and compressor. In summing up, it is suggested that a $\frac{1}{4}$ h.p. motor be used to drive the compressor by means of a vee-belt with a 1 : 2 reduction on the pulleys. Aircraft type air receivers can be obtained on the surplus market and though their individual capacity is not high, they can be "ganged-up" in parallel. They should be mounted vertically with the compressed air entering the bottom of the bottles and provision must be made for draining condensate from the bottom of the bottles. The drain cock should be opened when the compressor is not in use to eliminate the possibility of moisture collecting in the cylinders and setting up corrosion. It would be a sound plan to give the government surplus bottles a hydraulic test even if the working pressure figure is stencilled on the bottle, since one does not know the condition under which they have been stored. The fitting of a pressure gauge would also be a wise procedure. If an a.c. motor will not restart under load



The BTH type A.V. compressor dismantled



Heywood type SH6/2 compressor—drive and anti-drive ends

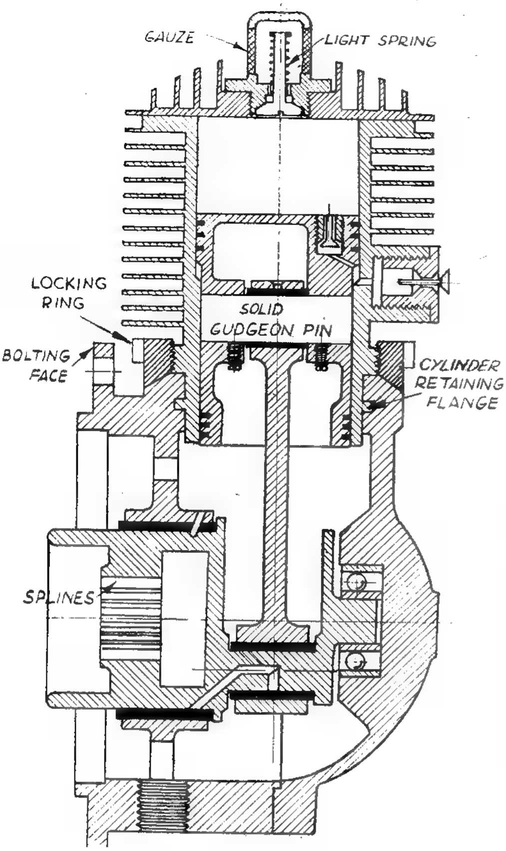


Fig. 2. Diagrammatic section of Heywood type compressor (not to scale)

when using the higher pressures, a manual release valve must be fitted to the delivery pipe to exhaust same and remove the starting load from the motor. In this event, a non-return valve will be required at the entrance to the bottle to prevent loss of pressure in the reservoir.

Used within its limits, this is a reliable compressor and needs no special cooling, the cylinder fins being sufficient. As will be explained later in this article, these compressors are unsuitable for use in refrigerators.

The second type of compressor to be described is illustrated herewith. It is the Heywood, type SH6/2 compressor (bore $1\frac{3}{4}$ in., stroke $1\frac{3}{16}$ in.), and readers will come across its kin under various titles such as Heywood-Bendix, Rolls-Packard, etc.

Apart from the fact that it compresses air, it bears little resemblance in design or operation to the BTH type just described; in fact, it looks more like a 50-c.c., two-stroke petrol engine, and quite a neat one at that!

The Heywood compressor will charge a 400 cu. in. cylinder to 300 lb. per sq. in. in 4 minutes at 1,200 r.p.m. or to 450 lb. per sq. in. in $6\frac{1}{4}$ minutes. The output is 1-2 c.f.m., designed normal speed is 1,200-1,600 r.p.m., and the maximum permissible r.p.m. for short periods is 2,100.

It is a two-stage compressor and does not rely on crankcase compression. The most interesting feature of this compressor is the stepped cylinder bore, the lower part being of reduced diameter. The piston is stepped to match, the larger diameter being at the top, and three sealing rings are fitted to both top and bottom of the piston. This is shown in the section (not to scale) illustrated in Fig. 2. The cycle of operations shown diagrammatically in Fig. 3 is as follows. On the induction stroke (i) the inlet valve *A* in the cylinder head is drawn open and allows air to flow into the cylinder; as the piston ascends (ii) the inlet valve *A* (assisted by a light spring) closes and the resultant compression

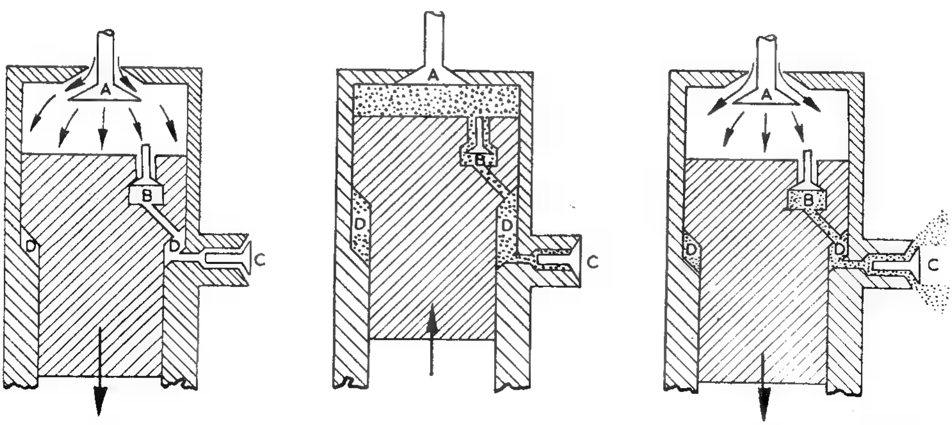
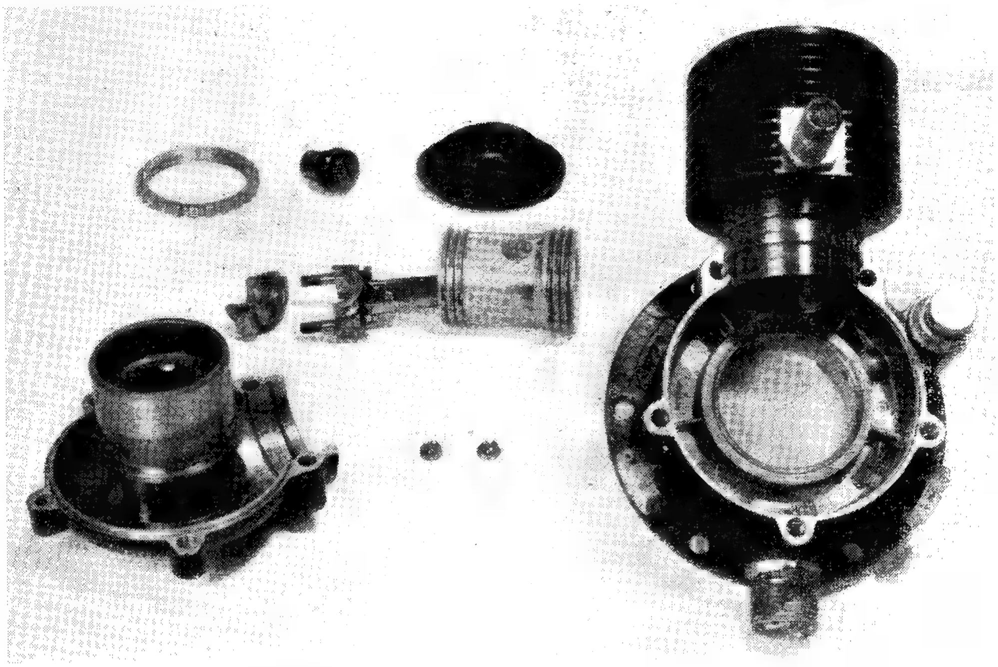


Fig. 3. Diagram of cycle of operations for Heywood compressor

forces the air past the transfer valve *B* in the piston crown into the annular space *D* between the reduced diameter of the piston and the larger bore of the cylinder. Since the volume of the annular space *D* is less than the swept volume, the air is now in the first stage of compression. The second stage of compression takes place as the piston descends (iii) and forces the air from the annular space *D* out through the delivery valve *C* to the receiver. At the same time, a fresh charge of air is drawn into the cylinder above the piston and the cycle of operations is repeated. Fig. 2 shows the salient features of design of which the most notable is the cylinder to crankcase joint. The two-piece light alloy crankcase is split vertically at right-angles to the crankshaft axis, and has a spigoted joint, the halves being secured by cheese-headed bolts. The base of the cylinder is housed between the crankcase halves, a groove being turned in the "neck" of the crankcase to receive an external ring or flange near the base of the cylinder. A multi-slotted locking-ring is screwed on the cylinder skirt, its conical face bearing against a matching face on the top of the crankcase. When the locking ring is tightened, the cylinder retaining flange is forced against the upper edge of the groove in the neck of the crankcase. This method of clamping the cylinder lends itself to alternative positions of the delivery valve through 360 deg. The gudgeon-pin, which was solid on the type examined, was secured by a grub screw in each piston boss. This is essential, for if the gudgeon-pin was allowed to "float" it could cause damage when that portion of the piston passed into the larger bore of the cylinder and the gudgeon-pin became "free." The "drive-end" crankcase bearing consists of a large diameter steel journal (with internal splines) running in a plain phosphor-bronze bearing of considerable area. The other end of the crank-shaft runs in a ball-race housed in the crankcase half. The big-end is split and is lined with white-metal.

In aircraft use, lubrication was carried out by the engine oil which was pressure fed to the compressor main journal at 30-75 lb. per sq. in. via a banjo connection on the anti-drive crankcase cover, which is shown blanked off in the photograph. The boss carrying the banjo connection houses an oil filter, through which the oil passes before entering the passage to the main journal. A port in the compressor bolting flange also communicates with the oil filter providing an alternative method of oil supply, depending on the type of aero engine to which the compressor is fitted. Whatever type of supply is used, the opposite connection is blanked off. The big-end is pressure fed via the main journal while the ball-race is lubricated by oil mist. The journal bearing also has an oil way in its top surface which directs a "squirt" of oil up into the cylinder bore at each revolution.

The light alloy cylinder head has a machined true flat face joint with the steel cylinder. The joint is sealed with a ring of lead wire which is flattened when the cylinder head bolts are tightened. This allows of the minimum clearance between the piston crown and the head at t.d.c., which is essential for high pressure work.



Heywood type SH6/2 compressor—dismantled

The cylinder temperature at the outlet boss should not exceed 110 deg. C., and a cooling blast is directed on that side of the cylinder when in use on aircraft. No adjustment for air pressure is provided on this type of compressor, since in use on aircraft it is used in conjunction with a Heywood pressure regulator and also an oil and water trap. The compressor may be mounted with the cylinder vertical or at 60 deg. either side of the vertical, so that one of the three oil drains is pointing vertically downward. An oil drain pipe is fitted to this drain and the other two are blanked off. In aircraft use, the compressor crankcase breathes via holes in the crankcase wall into the drive casing.

For use in the amateur's workshop, the following suggestions are made. For the lower pressures, a ¼ h.p. motor may be found suitable, but at least ½ h.p. will be necessary when using the higher pressures. A vee-belt drive with a speed reduction of at least 1 : 2 is recommended and an outrigger bearing must be fitted in the case of the BTH compressor. Whether high or low pressures are used, the provision of a relief valve in the system is most essential and the addition of a suitable pressure gauge would be an advantage. Air bottles may be "ganged-up" as mentioned earlier in this article with provision made for draining condensate. When purchasing these Government surplus bottles, make sure that you receive the correct bottle for the pressure you intend using. The bottles are marked with their working pressures and it is possible to buy one suitable for 300 lb. per sq. in. when actually a 450 lb. per sq. in. bottle is required. As mentioned previously a hydraulic test would allay any fears regarding the serviceability of these bottles. If a low pressure only is required, say 30 lb. p.s.i. the delivery valve on the cylinder may be removed. This cancels the second stage and the compressor reverts to single-stage working—requiring less power to drive. A larger volume of low pressure air could be obtained by running two of them in tandem, using a centrally disposed pulley to drive a compressor on either side. The compressors should be "timed" so that one is on the induction stroke while the other is on the compression stroke, and both delivery valves removed. A ½ h.p. motor should cope with such a layout. At low pressures, the cylinder cooling fins will probably be found sufficient, but a cooling fan will be required for the higher pressures.

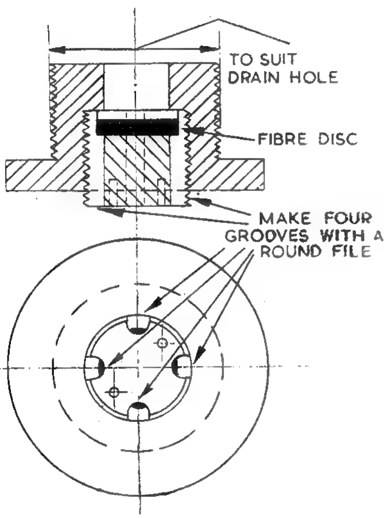


Fig. 4. Section and underside views of "silent" crankcase breather-valve

The method of lubrication is left to the discretion of readers, and may consist of a simple type of pump such as a cam and spring-loaded plunger, worm, or oscillating cylinder type, feeding direct to the banjo union on the compressor. A drain pipe should be fitted to the crankcase drain to return oil to the pump. The "open" side of the crankcase must be blanked off and a "breather" fitted.

The draw-back to pressure oiling is the danger of oil contamination of the air delivery to the receiver especially when used for paint spraying, due to the amount of oil splashing about inside the compressor. Though a combined oil and water trap is used on aircraft systems, this item does not appear to be available on the surplus market, and it is suggested that a more simple method of lubrication be tried—if it suits the taste of the reader—with less danger of surplus oil finding its way to the air line. The method is to use a "total loss" system with a sight feed lubricator fitted with an adjustable needle valve, feeding oil via the aforementioned banjo connection. The number of drips per minute must be found by trial and error, but a figure of 10 drips per minute is suggested as a start. A crankcase breather will be necessary and a simple form of this is shown in Fig. 4. It is fitted to the crankcase drain connection and has the added advantage of blowing out any surplus oil. The open side of the crankcase should be blanked off as before. Another point concerning paint spraying is that if a short delivery pipe from the compressor to the receiver is used, the receiver will become warm and condensation will take place in the outlet pipe to the spray gun, with the possibility of blooming or chilling. The ideal aim is to keep the receiver cool and so extract the maximum amount of moisture from the compressed air.

The government surplus compressors are not suitable for refrigerators, owing to the action of the refrigerant gases on aluminium parts. Although some of these gases are chemically inert in their pure state, it is often found that impurities set up chemical reactions which are very destructive to aluminium. Refrigerator compressors are generally made of iron and steel wherever possible, and a non-packing seal is used in the crankcase drive bearing.

If readers have difficulty in acquiring the splined driving shaft for these compressors, Fig. 5 illustrates simple methods of adapting drives for both male and female splines. In the case of male splines, bore the end of the driving pulley shaft a nice slide fit over the

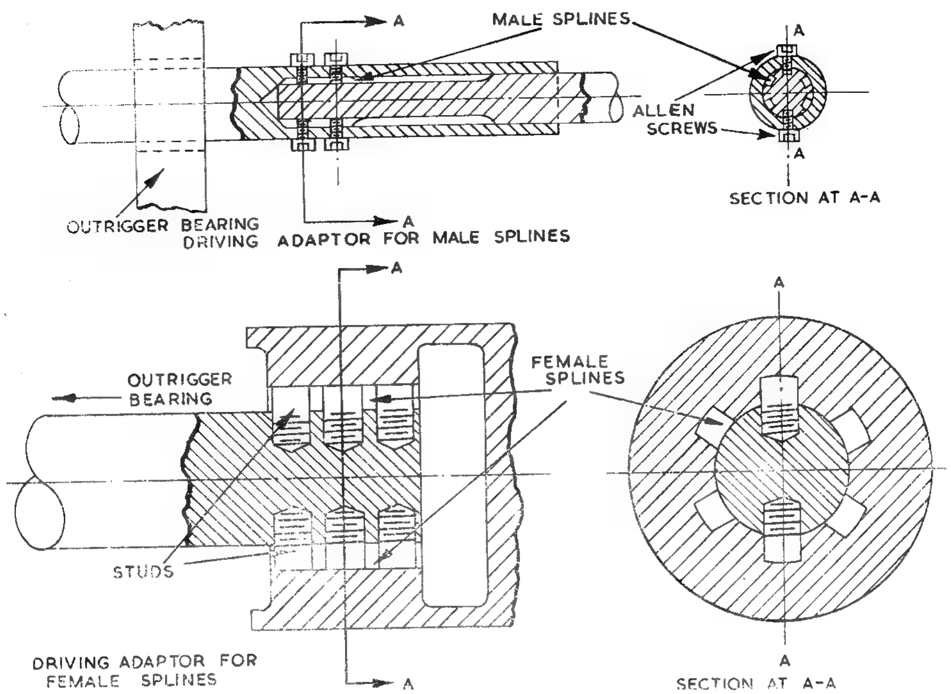


Fig. 5. Simple adaptors for driving male and female splined shafts

splines, and of sufficient length to pass over the "waisted" portion so as to embrace the full diameter of the splined shaft near the compressor bearing. Put Allen screws through this "tube" to engage the space between the splines. For female splines, select or turn a shaft to enter the inner diameter and screw in short studs as shown, to fit the spline recesses.

No doubt some readers who purchase this type of compressor will not be able to resist dismantling it just for "a wee look at the works." Here are one or two points to bear in mind on this particular model. If you are going to remove the inlet valve do so before removing the head—some assemblers can really tighten nuts! Next remove the head, and then slacken off the large locking ring which locks the cylinder barrel to the crankcase. Remove the crankcase screws and the driving end of the crankcase can be gently eased off. You are now left with the cylinder loosely engaged with the other half of the crankcase, yet with not enough play to draw it clear, because the crankshaft will be annoyingly held in its ball-race. Careful observation will reveal that a special tool is required to remove the crankshaft from the ball-race and an even more special tool to replace it—so leave well alone. The big-end must be split and the piston and connecting-rod drawn out through the top of the barrel. If you are one of the majority, who do not possess a cranked 2-B.A. ring spanner, the removal of the big-end nuts will be simplified if you use a suitable shortened 2-B.A. box spanner and tommy bar.

When reassembling, see that the screwed locking ring is in place on the barrel before mating with the crankcase half. Hold the cylinder (well padded) lightly in the vice, while you insert the connecting-rod and piston through the top of the bore. Since there is no chamfer at the top of the bore to give you the slightest assistance in inserting the rings, recourse will have to be made to the well-known dodge of using a thin sheet metal clamp to compress the rings. At this stage, make sure that the piston is inserted with the transfer valve on the same side as the outlet valve. The rest is plain sailing.

N.B.—Since the cylinder-head seal is a lead ring, make sure that clearance does exist between the piston crown and the cylinder-head.

An important point concerning these compressors is that a single cylinder compressor should be fitted with a suitable flywheel to minimise "snatch" on the driving belt. The use of higher air pressures necessitates the use of a flywheel of larger diameter.

A MODEL RACING CYCLE

by F. Harden

THE model to be described is $\frac{1}{8}$th scale of specially designed racing cycle. The complete model weighs approximately 4 oz. without the base and was constructed from odd bits of material. Working details include front forks, wheels, cranks, pedals, and Bowden brake.

The methods of construction were as follows :—

Frame

The main frame was built up from brass tubing and the stay-rods from brass rod filed to a taper in the chuck of a wheel brace. The parts were pinned in position on wood and the whole lot carefully soldered together.

Front Forks and Handlebars

The front forks were made of brass rod filed to shape with the spindle threaded 10-B.A. and screwed into a fitting in the handlebars, which were made from $\frac{1}{8}$ in. diameter copper tubing. Copper tubing was used to facilitate bending to shape.

Wheels

The wheel rims were made from brass tubing, bent to shape and silver-soldered at the joint. They were then filed away around the perimeter to leave them semi circular in section. Wheel hubs were then turned up out of brass rod. The chain sprocket was filed out of a thin steel washer and sweated to a boss on the rear hub. For building up the wheels it was necessary to make a simple wooden jig to hold the hub and rim in correct relationship. When the hub and rim were in position, four pieces of 16-gauge brass wire were soldered from hub to rim to fix the position. The assembly could then be removed from the jig for fitting the spokes. Before "spoking" the wheels, they were trued up by trial spinning and setting of the brass wires temporarily holding hub to wheel rim.

The wheel spokes were made from steel wire of correct scale gauge obtained from a steel pan-cleaning brush. Hubs and rims were drilled to take the spokes which were "cranked" in the hub and soldered to the rim. One side of the wheel had to be completed before removing the "keeper" wires holding the hub in position. Wheel spindles and wing-nuts were threaded 14-B.A. Tyres were made from rubber tubing joined by an internal wire.

Chain Wheel, Cranks and Pedals

The chain wheel was made from a disc of thin gauge steel, the spokes and teeth being filed out. Since the pitch of the teeth was difficult to mark out correctly, two wheels were scrapped before the third attempt proved O.K. The periphery of the wheel at the teeth was reduced in section by means of a small flycutter made for this purpose Pedals were built-up, using a piece of brass tubing for the centre, which was soldered to a top plate made from thin steel sheet filed to shape to include the toe grip. The cranks were made from brass with steel spindles for the pedals screwed 10-B.A.

The chain links were punched out of shim steel on a lead block and drilled with a small drill in a hand pin-chuck. Spacing washers were made by drilling holes in thin sheet mild-steel and punching out on a lead block by means of a small tool made from the steel point of a drawing compass fitted into a holder. The chain was assembled by means of wire pins riveted over.

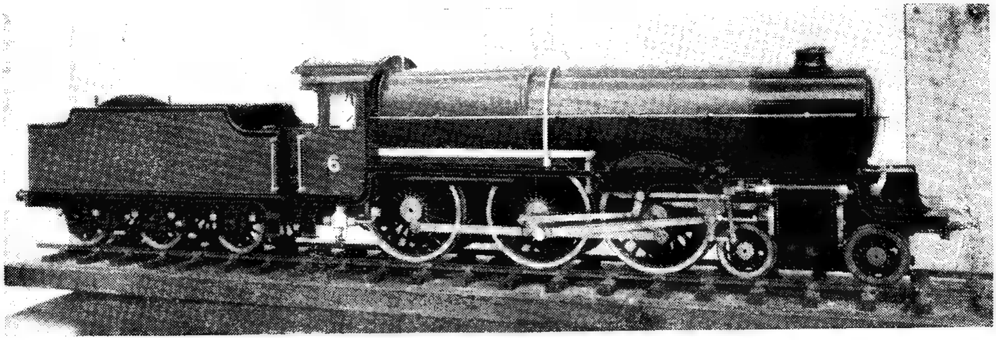
Front Brake

The working brake was of the Bowden type, the outer casing of which was made from short length of hypodermic syringe steel tubing and the inner cable was a strand of Bowden wire. The brake-block holder was of the caliper type fitted with small spring and complete with fibre blocks. The assembly was attached to the front fork by a pin passing through and soldered at the rear.

Saddle

The saddle frame was made from piano wire bent to shape of springs and soldered to a piece of tubing to fit into the cycle frame. The saddle seat was formed by punching a piece of shim brass into lead, using a correctly shaped punch filed up out of steel. The resulting brass shell was trimmed up and covered with very thin leather stuck on with "Durofix."

Before final assembly the frame and wheels, etc., were cadmium-plated and polished.



Mr. C. M. Keiller's 2½-in. gauge compound locomotive

A Suggested British Compound Locomotive

by C. M. Keiller

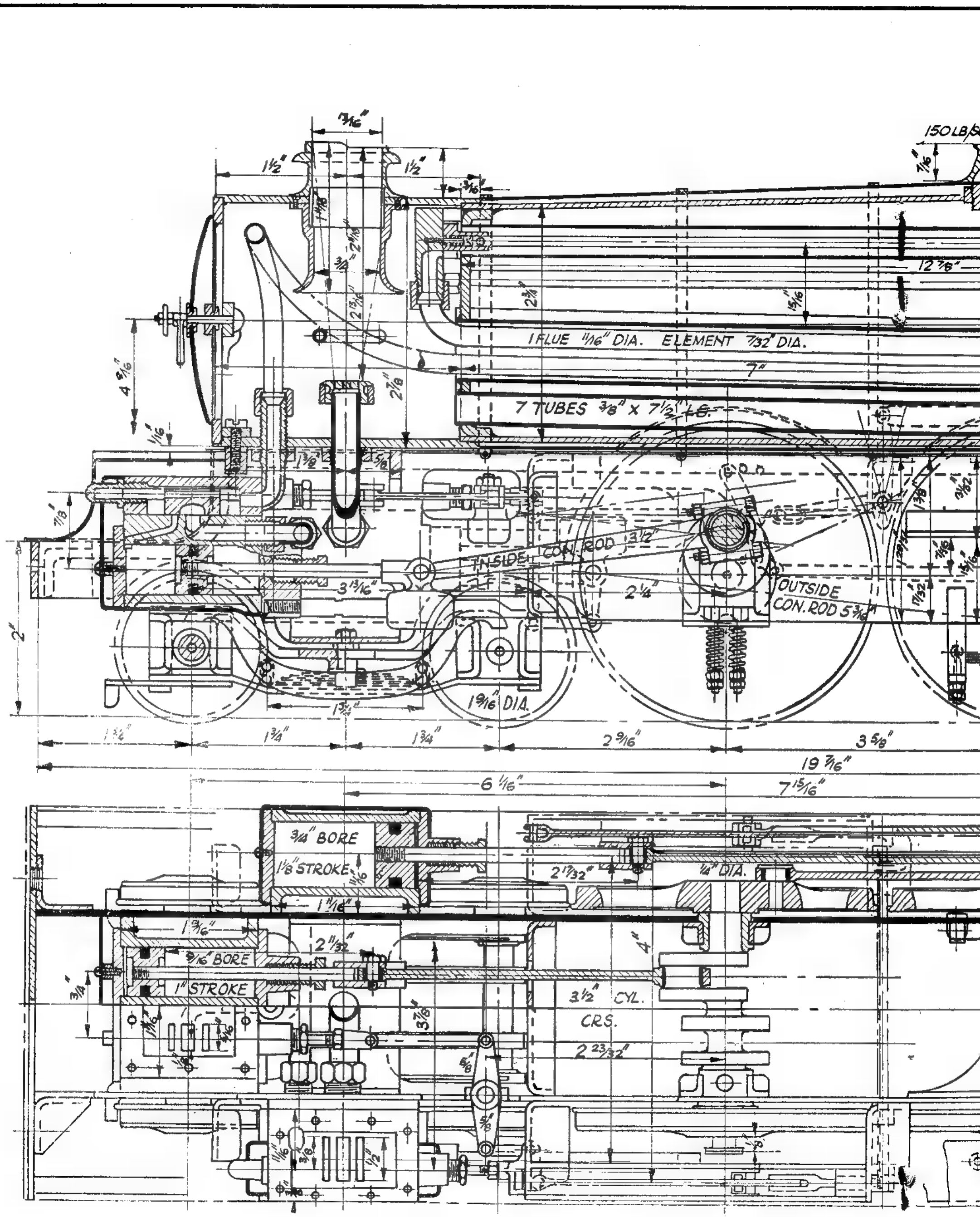
IN this country, the compound locomotive has always aroused a great deal of interesting discussion, but in practice has never been more than an experimental phase each time it has been introduced. Even the successful Midland design has remained an isolated class, which is on its way out after 47 years of practically unchanged design. The various reasons given for its unpopularity here are not really very convincing, as it is difficult to believe that traffic conditions are so very different from those of France; after all, there is no lack of popularity for the compound on road work, where one would have thought that the need for flexibility was very much greater than on the railway.

In the past, the general layout and detail of the design were very arguable, but there was little difficulty in finding room to put things where one pleased. Today, however, thanks to the work of Chapelon, we know a very great deal of what is desirable and necessary in a compound, but we are now faced with a very real difficulty in finding room for the L.P. cylinders together with adequate length of journal bearings. The French have managed, so far, as they have about 1 ft. more width than we have, but even they are now thinking of six cylinders, and they are generally satisfied with shorter journals than we consider desirable. So, in considering a design for this country, to get the maximum power, we cannot just copy that of Chapelon, and this model is my idea as to how it should be done. The whole design is really a prototype for the full size, the model being catered for only in the matter of the necessary detail alteration.

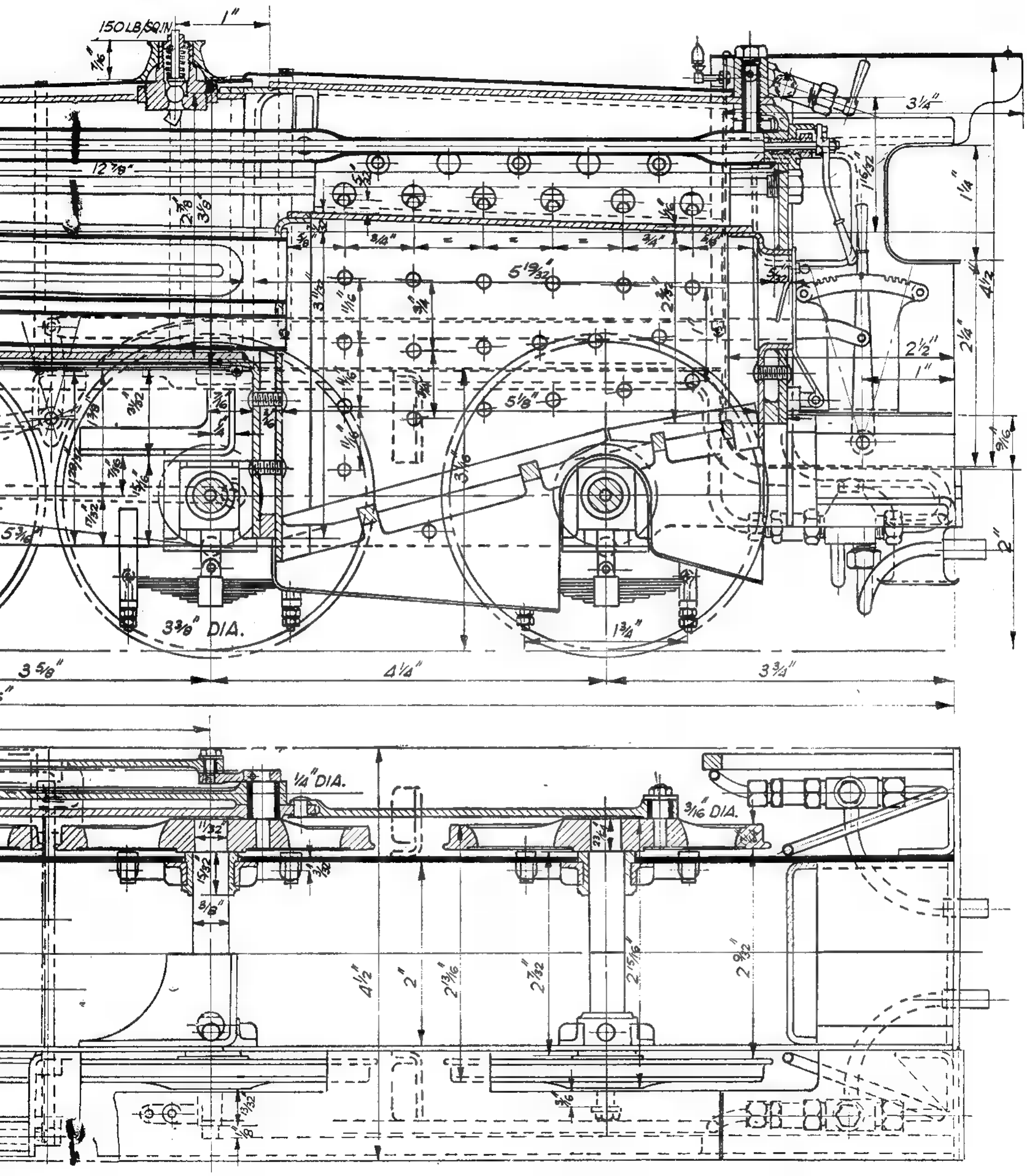
The model is ½-in. scale on 2½-in. gauge, which I know will meet with disapproval from some, but all my locomotives are so built, and I should always do so for the sake of uniformity. Anyway, it is not much out; it does not really represent a 5-ft. gauge, but about 4 ft. 10½ in., as the scale flange-to-rail clearance would be quite unworkable on 2½-in. gauge. Actually, the model is just about that scale 2 in. wider than the British load gauge; the height is equivalent to 13 ft. 3 in.

The salient feature of the design is the detail positioning of the cylinders; the L.P. are in the normal position outside between the bogie-wheels and would be 22 in. × 30 in. at 6 ft. [illegible] in. centres. The H.P. are over the front bogie axle and would be 15½ in. × 28 in. at 1 ft. 5½ in. centres, and this arrangement would allow of a 10-in. journal if the wheel seat, crank axle, pins and webs were of the same length as on the L.M.S. 4-6-2's. With this arrangement, the piping works in at least as well as with the De Glehn design, and it has the advantage that the wheelbase does not have to be stretched out to get a reasonable length for the inside connecting-rods. The L.P. cylinders may seem a little small, but they are 89 per cent. of the volume of those of Chapelon's 4-8-0's. However, I think 300 lb. pressure would be needed to get the required tractive effort; larger cylinders can be got between the frames, but the length available for the journals would not be nearly enough.

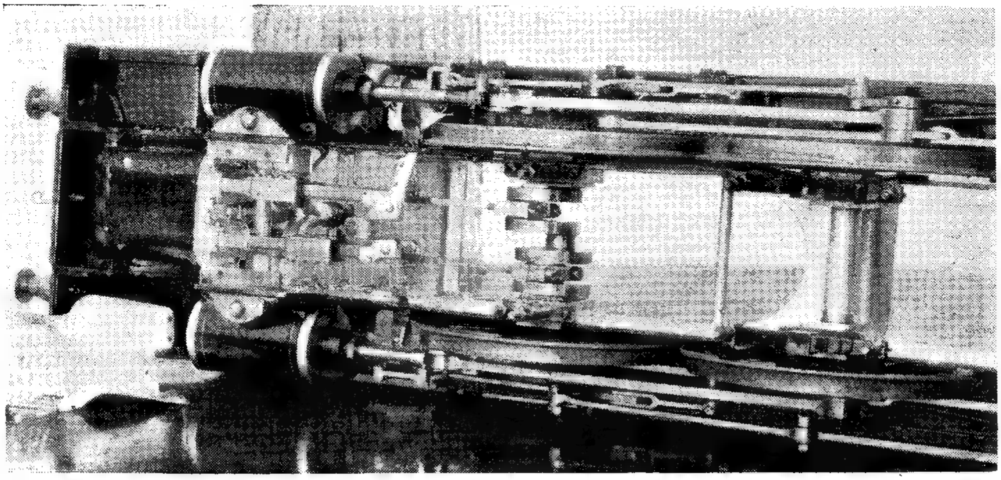
The locomotive is not a 4-6-2 because the measure of power of a compound is the L.P. cylinder volume and when the largest size possible here has been provided, then the appropriate H.P. cylinders will still be of such a size that a 4-6-0 boiler of maximum size, such as that of the G.W.R. "King's," could easily supply them. Again, if Chapelon efficiency is obtained as it should be, the "King" boiler would develop well over 3,000 i.h.p. Chapelon's own estimate for a very similar boiler is 3,600 i.h.p., and this is as much as any existing British 4-6-2 develops. Starting gear is necessary in a full-size compound, though Webb did not seem to think so, and, in my opinion, a supply of boiler steam, preferably superheated to the receiver, is all that is needed. By allowing the



Sectional elevation and plan of th 2½-in. g



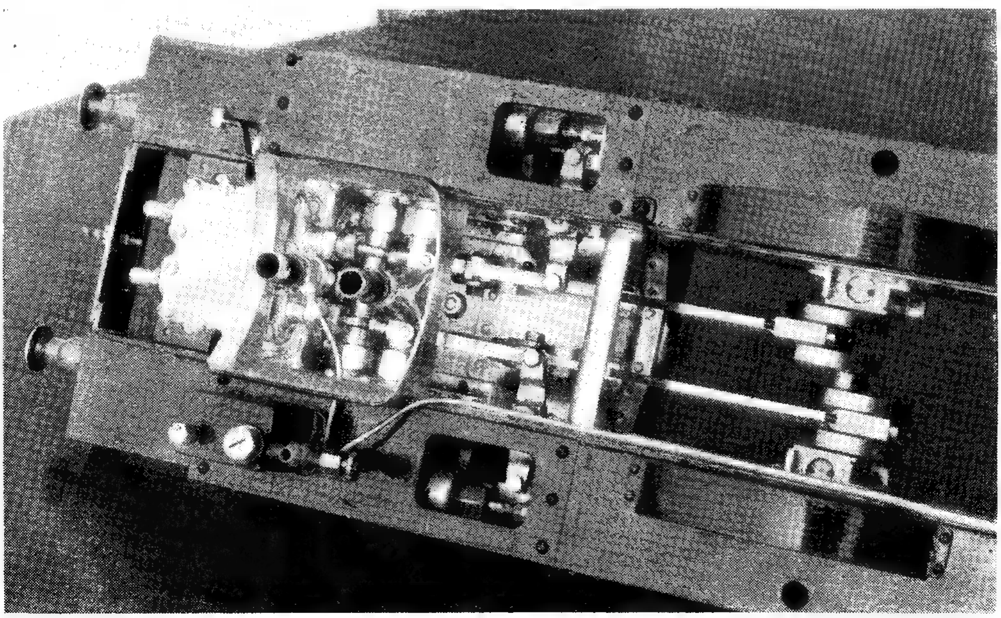
...n of the 2½-in. gauge compound locomotive



A view of the motion from underneath, undershield removed

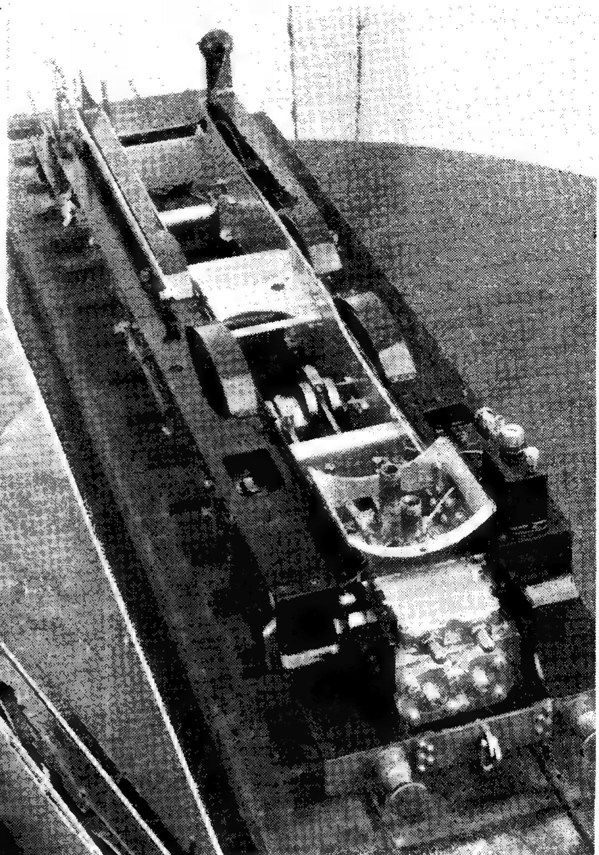
H.P. pistons to float, the full boiler pressure can be used on the L.P. pistons, and by judicious use of the auxiliary steam, the tractive efforts can be boosted at low speeds, much the same as with the Smith reducing-valve fitted to the original Midland compounds.

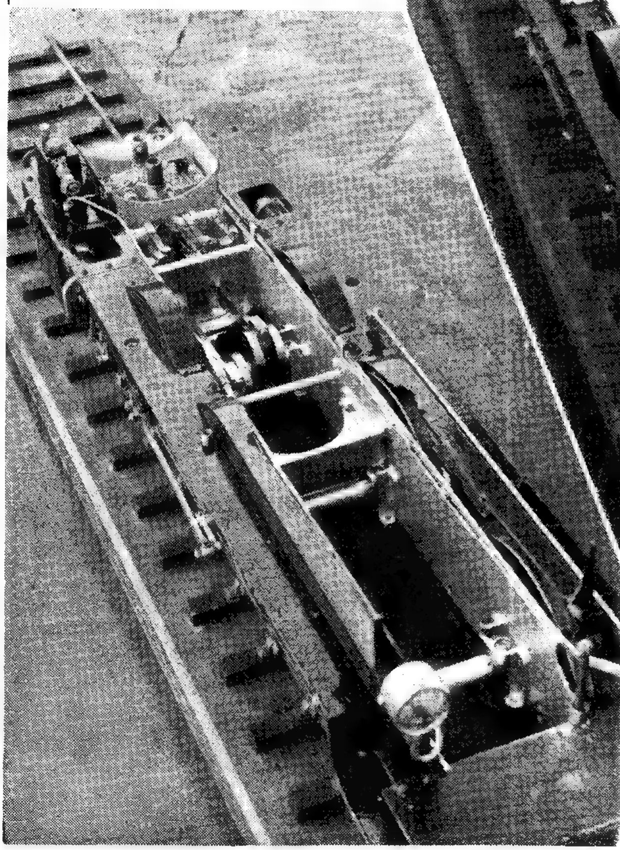
French designs, as a rule, use the long-established De Glehn system with change valve and auxiliary regulator, whereby the locomotive can be run as a pure compound, an assisted compound as above, four-cylinder simple, H.P. engine only, or L.P. engine only, both using boiler steam. Very nice, but does it really do much more than a simpler arrangement? Of course, the H.P. and L.P. engines can be run as independent units and develop quite a lot of power; but if they are properly designed for compound working, they cannot be efficient as simples. A single expansion unit needs a minimum clearance volume and line-and-line exhaust setting or thereabouts, but if this be used on an engine exhausting into 60 lb. to 100 lb. pressure, the resulting compression at the end of the stroke would be enormous on anything approaching



A view of the saddle, showing arrangement of pipes

The chassis as seen from above, either end





Two views of the chassis; lagging of H.P. removed

short cut-offs. Hence the necessity, in early compounds where this was not understood, of keeping the L.P. engine in full gear to reduce the receiver pressure, and in modern compounds of large clearance volumes and exhaust clearance. The clearance volume of the H.P. cylinders of the Chapelon 4-8-0 is 25 per cent. and of the Midland engines 17 per cent., so it is obvious that such H.P. engines exhausting to the atmosphere would be very wasteful at any cut-off.

So much for the full size edition. The model has $\frac{3}{4}$ in. × $1\frac{1}{8}$ in. L.P. cylinders and $\frac{9}{16}$ in. × 1 in. H.P. cylinders with $3\frac{3}{8}$ in. driving wheels and 150 lb. pressure, outside Walschaerts gear driving the inside valves through plain rockers. The valves have long steam laps, which I think I can claim to have introduced to model work in 1919. The events are arranged to suit compound expansion. The ports and passages are large and well shaped; but there is nothing excessive, and no sudden change in area, starting with a steam pipe of 5/32 in. bore and finishing with a L.P. exhaust pipe $\frac{1}{4}$ in. bore. The cylinder passages are single oval holes of about the same area as the steam ports. These are: H.P., $\frac{5}{16}$ in. long and L.P., $\frac{1}{2}$ in. long. All the passages are of as good shape as if they had been cast in, with the added merit of smooth walls; the H.P. cylinder clearance is about 18 per cent.

(*To be continued*)

A MODEL VERTICAL BOILER

JUDGING by correspondence that I have received, considerable interest seems to have been aroused by the photograph published on the cover of THE MODEL ENGINEER dated October 6th, 1949, of my vertical boiler.

The original idea of the boiler was to test steam fittings, and it has been the instrument through which the myth of "pop" has been finally exploded from several commercial steam safety-valves.

However, the barrel is 6 in. diameter, 12 in. high, and $\frac{1}{16}$ in. thick, in solid drawn copper, giving a working pressure of about 70 lb. per sq. in. The firebox is brazed, and contains fifteen $\frac{1}{2}$ in. diameter tubes which are screwed in, and expanded and sweated the other end.

At the base, it is riveted and sweated to the barrel, as is the top tube plate. Four wash-out plugs are provided, and fittings include water gauge, steam gauge, and two check-valves ; and all are in the form of flanges which are riveted and sweated in their appropriate positions.

The main steam supply pipe has one coil over the tubes before emerging from the smokebox, a modification since the photographs were taken.

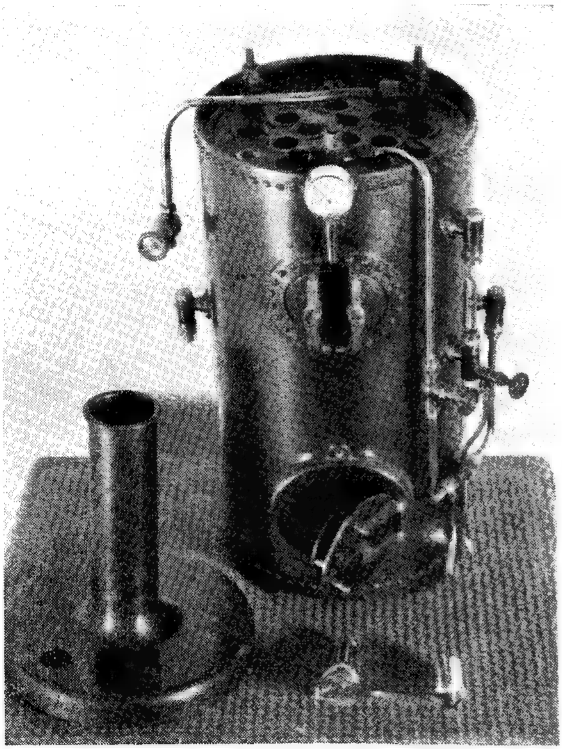
The finish is perhaps pleasant to look at, though certainly not pleasant to produce, but for those interested, here it is.

Parts should have all oxides caused by heating, etc., removed. This can be done by wiping over with muriatic acid (spirits of salts) on a cloth or old brush. All parts should then be well swilled in cold water and finished off with a rinse in soda water to kill any trace of acid remaining.

Next, scour all parts by brushing with water and pumice powder until a matt surface is produced, free from grease and finger-marks—this is important for a good finish.

While still wet after scouring, dip and move about in the solution until a steel grey colour covers the surface, remove and swill in clean cold water and dry with a cloth or rub in sawdust. The surface is then well brushed with a clean dry brush by hand or scratch-brushed with a circular revolving brass wire brush, the latter giving a blacker and brighter finish. The parts are then lacquered.

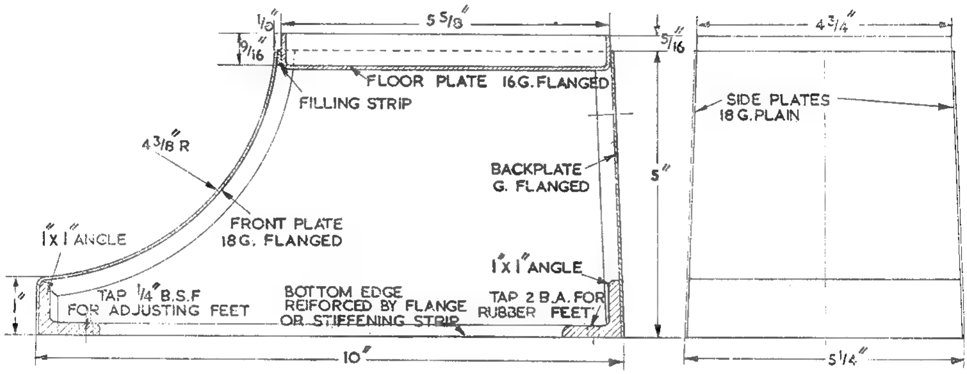
The dipping solution is made up by dissolving 2-4 oz. of liver of sulphur to one gallon of cold water.—S. T. HARRIS.

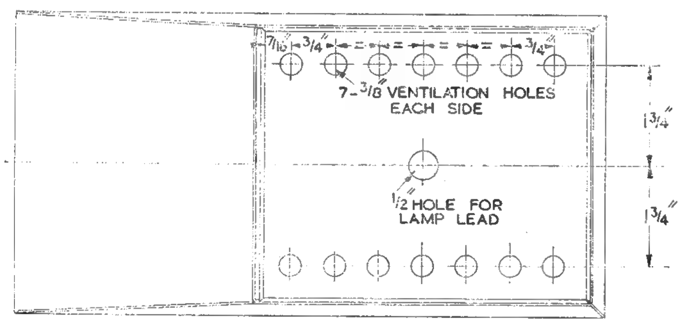


*Miniature Slide and Strip Projectors

by "Kinemette"

IN the method of construction to be described for the "Universal" type of projector, sheet metal is used to fabricate the base and lamphouse. These components will present no difficulty to the skilled sheet-metal worker, who will probably have his own methods of dealing with them, and will not need detailed instructions on procedure. but the thicker material will be harder to work and increase weight, while thinner material, while quite strong enough mechanically, will be found more prone to stretching and cockling in the bending operations, and may require some stiffening of large plain areas, such as the side panels of the base. Some parts of the structure





Details of base

For the benefit of the uninitiated, however, simplified methods of construction have been adopted, which should eliminate any serious difficulties, and enable a sound and neat job to be produced. It has not been considered necessary to give development plans of all the individual sheets of metal used in construction, as the shapes are not complicated, and allowances for bending and flanging do not necessarily involve critical measurements.

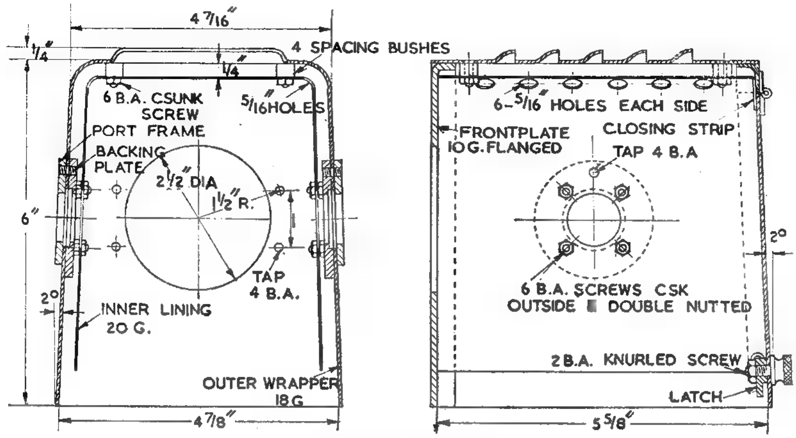
The material recommended for most of the work is aluminium sheet of about 18-gauge; either thicker or thinner material could be used, are made of thicker material to withstand extra stress or weight, while in one or two cases, thinner material is quite appropriate.

Except in cases where the necessary skill and facilities for welding are available, the best method of joining the parts is by riveting. The size of rivet most suitable is about 3/32 in., and snap heads may be used, put in from the inside, the holes being slightly countersunk, so that the rivets can be finished flush with the outside surface. Soft aluminium rivets are easiest to use, but if aircraft rivets are employed, they should be annealed immediately before use. Assuming that the components are to be enamelled when finished, it would be quite in order to use copper rivets. The rivets should not be longer

*Continued from page 828, "M.E.," June 8, 1950.

than is required to project a bare $\frac{1}{16}$ in. above the metal surface, and if cut to length with pliers or side cutters, the ends should be filed flat and square before heading. A fairly close fit of the rivet in the hole is desirable to avoid the risk of bending and distortion under the hammer.

The materials actually used on this projector were obtained from more than one source, but most of it, including rivets, was obtained from Messrs. K. Whiston, of Stockport, whose advertisements appear regularly in THE MODEL ENGINEER, and the writer would like to express appreciation of the service given and the trouble taken to satisfy special and unusual requirements.



Details of lamphouse

Construction of Base

This is built up from five separate sheets, four of which—the two sides, front and back plates—are of 18-gauge material, while the top plate, which actually forms the floor of the lamphouse, should not be less than 16-gauge, as it is essential that it should be rigid, especially if the transformer is to be attached to the underside. The side plates require no bending, and may be cut out exactly to the shape and dimensions shown, but in cutting out front and back plates, an allowance of $\frac{3}{8}$ in. each side is made for bending the flanges, and in the case of the front plate, the length of the curved portion should be about $6\frac{1}{4}$ in. before bending, not counting the 1 in. for the vertical part of the "toe." Note that in work of this nature, it is difficult to compute exact measurements because of the stretching which will take place in the bending operations, especially when there is any hammering to be done. The old hand knows by experience just now much the metal will stretch when working to well-tried methods, but the novice will often find it a varying and sometimes bewildering quantity. In this particular case, the ends of the material may be trimmed after bending, but neither this nor the width need be made to precision limits.

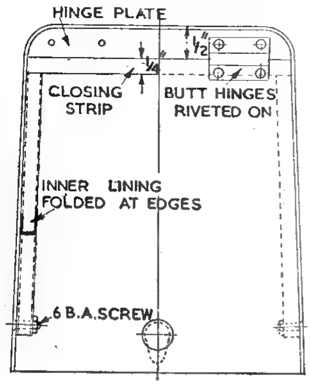
The backplate of the base is simply bent at right-angles to form the flanges, which is quite a simple operation, and one which is often done with practically no special equipment whatever by experienced workers. But to facilitate a straight bend, without distorting the sheet, the novice will find the following method useful: Get two pieces of fairly heavy rectangular bar, or angle-iron, of say, 1 in. width, with a clean face and edge, long enough to cover the greatest length of edge which is to be bent, with an allowance of an inch or so at the end. Drill the ends, beyond the width of the sheet, so that they can be clamped together by two bolts with their edges in line, and with the sheet sandwiched between them. (If the appliance is to be used for material of various widths, a number of bolt holes can be made in the bars to enable the bolts to be spaced as closely as allowed by the width of material to be clamped.)

The material is marked out to show the bending line, and this line is set to coincide with the edge of the bar when it is clamped up; a few blows with a hardwood mallet will then suffice to turn the flange down neatly and squarely. Aluminium sheet of soft or "half hard" grade is very ductile, and will bend quite easily; the harder aluminium alloys, however, are much less tractable, even when annealed, and are much less suitable for this particular job.

The front plate entails a more complicated bending operation, but it is not really difficult if tackled in the proper way. If a flat-crowned wood or metal pulley of approximately the correct radius is available (one need not split hairs over this dimension) it will serve nicely as a former, and the sheet metal may be bent to fit over it by hand; it may, however, be necessary to make a former specially, and any scrap piece of wood may be used for this, provided that it is large enough to cover the full width of the sheet, and long enough to make a 90 deg. sector of a circle, of the specified radius. A backing-piece to fit the inside curve of the sheet will also be required, and this should be made of hardwood, but need not be more than about $1\frac{1}{2}$ in. wide. Both the former and the backing-piece should be tapered,

so that when the sheet is clamped between them, they can be set to coincide with the bending line. A pair of large G-shaped clamps, or any other convenient method of gripping the assembly with firm pressure during the flanging operation, may be used.

In forming the curved flange, the metal will



Rear of lamphouse, showing method of fitting door

have to stretch a good deal, and more gradual bending will be found necessary. Some workers may prefer to slit the edge at points about $\frac{1}{2}$ in. apart to simplify the operation, but this detracts from the rigidity of the finished flange, and should not be found necessary. It will, however, be desirable to cut a 90 deg. vee notch at the corner of the vertical bend at the front of the toe. When flanging sheet metal over wooden formers, the softness of the latter will usually make it impossible to obtain a dead sharp internal corner, so that the outside of the angle will be still more rounded, but that is no disadvantage for the particular class of work now under discussion.

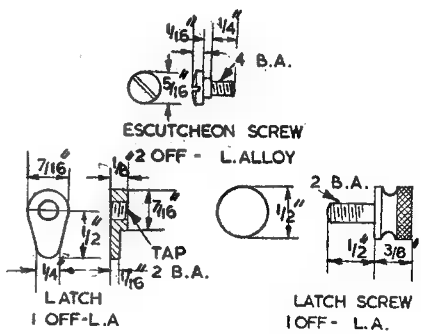
The floor plate has allowance for turning up the sides $\frac{5}{8}$ in. all round, and it will, of course, be necessary to cut 90 deg. notches at the four corners before bending. A wooden former cut to the exact internal size of the floor plate will enable the bending to be done easily and neatly. Drill the ventilation holes in the plate after bending, for preference, as they will not then affect the rigidity of the main panel or produce a possible risk of distortion. The spacing of rivets should be about $\frac{3}{4}$ in. apart for all the riveted joints.

In assembling the base, the front and back plates should first be fastened to the sides, and then the floor plate put in. Note that at the front of the floor plate, a filling piece is interposed between its flange and the front plate; the object of this is to make up the difference between the thickness of this plate and the 10-gauge front plate of the lamphouse, so that the latter lies flush when assembled. It is advisable to drill all the rivet holes in the side plates before assembly; holes are then drilled in the flanges of the other plates to coincide at salient parts, and the structure temporarily held together by 3/32 in. bolts and nuts; the rivet holes are then drilled, first at fairly wide spacing, and rivets fitted, working at closer intervals progressively till all rivet holes are filled. The heavy angle pieces at the front and back edges of the base, which may with advantage be of harder material than the sheets, may be fitted last, using rivets spaced as before. As the bottom edges of the side plates have little inherent rigidity, a reinforcing strip of light bar or angle is useful here; alternatively, the skilled metal worker may prefer to allow for turning the edge of the panel inwards or form a beading, internally or externally, for the same purpose.

Lamphouse

For the main wrapper sheet of the lamphouse, a single piece of 18-gauge sheet, 17 in. long, was used, and incidentally, instead of plain sheet metal, ribbed aluminium sheet, as used for covering footplates, etc., may be recommended if available, not only on the grounds of appearance, but also to assist dissipation of heat. The bending of this sheet can be done by hand, using a piece of 1 in. bar held in the vice as a former, but before doing this, the louvres in the roof should be formed. This is an operation which some workers may find rather difficult, but again the use of simple appliances will expedite and simplify forming operations; in this case all that is needed is a piece of bar about 1 in. wide, with a groove along it to coincide with the external shape of the louvre, and a fairly broad forming punch of mild-steel, shaped to the inside contour.

Slits are first pierced in the plate in the required positions, $\frac{3}{4}$ in. apart, using a broad thin chisel such as an old wood chisel, and backing up the work with a hardwood block. The grooved bar is then held in the vice, and the louvres first roughly hammered into the groove with a cross-pene hammer; the forming punch is then applied to produce a clean shape, the open edge



Minor lamphouse details

of the louvre being pressed firmly against the vertical side of the groove during the entire operation. In order to form the ends of the apertures neatly, the ends of the punch should be well rounded off, and care taken to make all apertures the same length and properly aligned. The edges of the apertures will need to be filed to clean them up and eliminate chisel-marks.

If preferred, the roof of the lamphouse may be made separate, and attached to the side panels

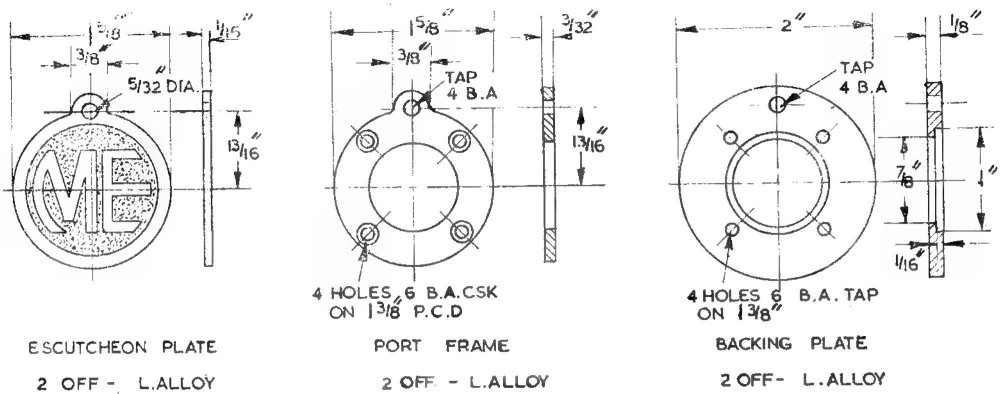
by a lap plate riveted underneath, just outside the width of the louvre apertures. It will be seen that spacing bushes are fitted under the roof to take the screws which support the inner lining of the lamphouse, and these may with advantage be permanently fixed to the roof by making them in the form of hollow rivets, as this will very much simplify assembly.

The front plate of the lamphouse is made of thicker material, as it supports the weight of the entire optical system. It may be flanged over a hardwood former, as described for the floor plate of the base, but the rounded corners will call for some patience, as the metal has to be compressed at this point. The same former may be used to flange the hinge plate which is fitted at the back of the lamphouse, though in this case thinner material (18-gauge) will be quite strong enough.

It will be noted that the inner lining of the lamphouse consists of a single sheet of aluminium bent to conform with the contour of the outer wrapper, allowing a space of approximately $\frac{1}{4}$ in. between the two for air circulation. This is specified as 20-gauge, but much thinner material is quite suitable, as it has no structural duty. It is made just wide enough to fit neatly inside the lamphouse and the bottom edge is about $\frac{5}{8}$ in. above the bottom of the latter. At the rear edge, the lining is folded over so that it forms a closing strip at the sides of the rear flap door, and can be attached at one or more points to the outer wrapper by 6-B.A. screws or 3/32-in. rivets. Note that this fold must terminate at the edge of the closing strip which is fitted to the bottom of the hinge plate, across the top of the back of the lamphouse. Alternatively, strips of $\frac{1}{4}$-in. channel section material may be fitted here.

The lining is also attached to the inner ends of the countersunk screws which secure the port frames and their backing plates at each side of the lamphouse. Exit vent holes are drilled along the bend of the lining plate: note that these should be staggered in relation to the position of the louvres, to ensure perfect light-trapping.

After riveting the front plate and the hinge plate to the wrapper, the lamphouse should be "offered up" to the base, so as to make sure that dimensions coincide, ensuring flush fitting at front, sides and back. It is advisable not to rivet the two components permanently together, but to fasten them with 3/32-in. or 8-B.A. countersunk screws, spaced about 1 in. apart, about $\frac{3}{16}$ in. from the bottom edge at the sides and front of the lamphouse, tapped into the flanges of the floor plate. This will enable the lamphouse to be dismantled easily, if it should be necessary at any time.



Inspection port fittings

The rear door should be fitted after the lamphouse is in position. Its sole object is to prevent the escape of light, when once the necessary adjustments have been made in the position of the lamp and reflector; for this reason, it should be made a close fit inside the edge of the wrapper plate, and bed down neatly on the closing strip at the top edge, the folded back edge of the inner lining, and the back flange of the floor plate. The hinges shown are ordinary butt hinges, such as can be obtained for a few pence a pair at Woolworth's, or the local ironmonger; they should not be more than about 1 in. long, or they will look clumsy. They will probably be obtainable only in brass, but this is quite satisfactory unless the projector is to be left unpainted. The skilled metal worker will probably prefer to form the hinges in the door and hinge plate, which makes a much neater and stronger job when properly carried out.

Latch

Any simple form of fitting which will keep the door properly closed may be used here; the one shown in the detail drawing consists simply of a "turnbutton," embodying a tapped boss with an extended lug, and a knurled screw, which is locked by means of a nut, assisted, if necessary, by a shakeproof washer. An index mark may be made on the head of the screw after the latter has been assembled and adjusted, to show the fastened position.

Inspection Port Fittings

These are shown in detail, and call for little comment; they may be made from simple castings or from aluminium alloy plate. It will be seen that the backing plate has a recess to take a coloured glass disc, which should fit quite

(*Continued on page* 923)

A Little Bit of Old Ashford

by "L.B.S.C."

IT was our old friend, Mr. J. N. Maskelyne, who once said that the best way to test the realism of a little engine, was to take a photograph of it, from the same viewpoint as you would take a shot of the full-sized engine. Well, what about the little lady illustrated here? Apart from the railway, which is more utilitarian than realistic, there is little to distinguish the *Maid of Eastcote* from her full-sized sisters who were "born" at Ashford, or contractor-built to Ashford drawings and specifications. The union nut on the boiler clack (the big engines had square flange joints) a few screwheads, and the slight extra width of the wheel treads, are about the only things that betray her as a 5-in. gauge locomotive instead of 4 ft. 8½ in.

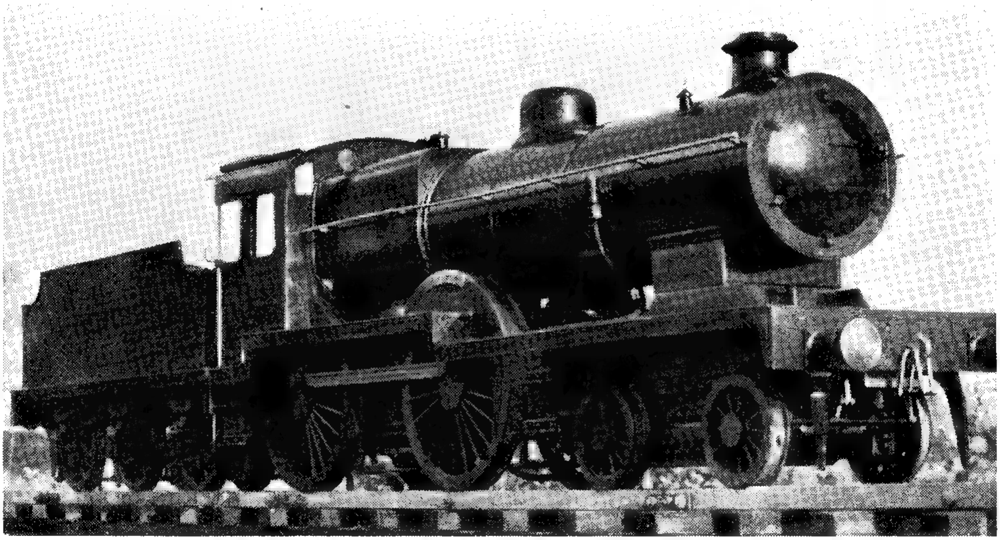


Photo by] *A reminder of S.E. &. C.R. days* [*Mr. Harvey*

The engine is the handiwork of Mr. P. R. Fairbairn, of Eastcote, Middlesex. She is a first attempt at locomotive-building, and took just over two-and-a-quarter years to complete; but our friend says he was amply repaid by the thrill of driving her. She performs in true "Southern L1 class" style; on Easter Sunday, running on the Watford Society's line at Chipperfield, which is approximately 850 ft. around, and has a bank in it, she made easy work of a load of four adults and sixteen children. She "chopped 'em off" in fine style going up the grade. She also did nine laps non-stop with driver and six adult passengers at an average speed of 10 miles per hour, timed from a "dead stand" start, and finished up blowing off. Running with four passengers, and the lever in next notch to middle, the blast is barely audible, and the firehole door has to be kept open to prevent excessive blowing-off; whilst the water tends to creep up the glass, with the pump by-pass fully open, so there isn't much amiss with either boiler or motion.

Take heed, all ye beginners—this engine was built by a brother beginner by following implicitly the drawings and instructions I gave for the *Maid of Kent*, and he got the guaranteed results. In the Kodak Exhibition, held not so long ago, the engine was fourth in the list, with a "Highly Commended," for which the builder deserves hearty congratulations. Any beginner can obtain the guaranteed results, if he follows our worthy friend's good example, and sticks to the "words and music"; but unfortunately there are a few who either "know better" themselves, or else take the advice of the gentleman found in every club, who "knows the all answers," and can better anything ever designed by Churchward, Gresley, Maunsell, Chapelon & Co., to say nothing of such lowly folk as your humble servant. The result is disappointment, and my correspondence tells a tale. I know of a professionally-built *Minx*, the beats of which are enough to make an angel shed tears of Baker's fluid. If the valve-gear, ports, setting, etc., were *exactly* to my specification—and I mean just that—the engine would do the job exactly the same as Mr. Fairbairn's; but nobody could teach the builder anything—'nuff sed!

How Poppet Valves Work

The reproduced photographs came to hand a little sooner than I expected; so here goes to fulfil my promise of last week, to try to explain simply, for beginners' benefit, the "hidden secrets and mysteries" of a poppet-valve gear. Seeing the actual thing, or what is next best, a close-up photograph of it, is always far better than yards of drawings, and pages of detailed explanation. Just after the end of the late orgy of bloodshed and destruction, a very esteemed friend presented me with a gadget consisting of a small sectional cylinder with Lentz poppet-valves, instead of the usual slide or piston valves. To the best of my knowledge and belief, it was used by a Jerry traveller for demonstration purposes when visiting the full-sized locomotive-building fraternity. It is a lovely example of precision workmanship, nickel-plated all over, and reposes in a leather-covered plush-lined case, the outside of which bears evidence of having travelled around in its late owner's pocket for quite a considerable time. Mr. L. J. Hibbert got busy with his photographic apparatus, and made just as good a job of the prints as the Jerry craftsman did of the cylinder.

This isn't going to be any technical dissertation, but as simple as a kiddies' bedtime story; so I'll presume all beginners either know, or can realise the fact that a slide- or piston-valve only gives its maximum port opening when the valve-gear is in full forward or backward position. As you notch up, and the valve cuts off earlier, the port opening gets smaller and smaller, until by the time you get next to middle, it is only just a mere crack. Therefore, unless there is a big lead on the valve, you don't get full pressure on the piston-head at very short cut-offs. Also, there is the bugbear of compression, which increases as the gear is notched up, owing to the early closing of the ports. The ideal valve events would be, to get a full port opening every time, irrespective of the cut-off point; that is to say, the valve should move as far over the port at 15 per cent. cut-off, as it does at 75 per cent. cut-off, only returning and closing it quicker. At the same time, the exhaust port should remain open long enough to allow free escape of spent steam, until the piston very nearly reaches dead centre, so as to avoid trapping steam in the cylinder on the return stroke, and preventing the piston acting as a "compression brake." As I mentioned a few weeks ago, the presence or absence of compression in a cylinder makes all the difference in the world to the power output. Excessive compression in one cylinder means that the other must put out power to overcome it, thus robbing the engine of drawbar power. I guess beginners will see that quite clearly.

The Wasps in the Jampot

Certain locomotive engineers thought to get over all the trouble at one fell swoop, by substituting poppet-valves for piston- or slide-valves. They argued that with a suitable arrangement of cams and tappets, the poppet-valve could be smacked wide open, and could either be left wide open until the piston had travelled 75 per cent. or more of the stroke, or flicked shut again immediately, cutting off steam almost as soon as the piston moved. One inventor claimed a 2 per cent. cut-off *with full port opening.* As the valve operated in the steam-chest, and merely opened and closed a port, same as in an automobile engine, it was obvious that the exhaust couldn't go out the same way as it came in; so internal combustion practice would have to be followed, and a separate exhaust valve used at each end of the cylinder. This was quite O.K., because the exhaust valve setting was thus made quite independent of the admission timing, and therefore the exhaust port could be made to remain open as long as considered desirable, reducing back pressure to the minimum.

On paper, this was theoretically perfect, viz. a full port opening at every point of cut-off, and an unrestricted exhaust. In practice, there were a couple of fine big wasps in the jampot; in fact, they proved veritable hornets. No. 1 was that there was no infinitely-variable cut-off point, such as could be obtained with an ordinary valve-gear, if the usual arrangement of cams and tappets were used. No. 2 was the concussion, and subsequent leakage, of suitably-sized poppet-valves. If those who read this, are car owners who do their own decarbonising and valve-grinding, they won't need reminding of the condition of their valves and seatings after a fair amount of running, due to the hammering they get. If these little valves "go through it" to such an extent, it doesn't need much imagination to grasp the effect of a huge valve as big as a dinner plate, bashing down on its seating at every stroke of the piston, with steam pressure added to spring pressure. Locomotives fitted with poppet-valves, when fresh from the shops, were all that could be desired; but after a short period of running, it was a different tale altogether. Drivers and firemen can tell you more about that, than I can; whilst the maintenance staff could say their little piece as well, with embellishments. Anyway, it is very significant that the Great Western tried poppet-valves on one solitary engine, and then abandoned them—and nobody could accuse the Swindon folk of not doing everything to increase efficiency, seeing that the most efficient locomotives running in this country at the present time, are based on Swindon practice.

The Oscillating Cam Type

There are two types of poppet valve-gear, one called the oscillating cam type, and the other, the rotary cam. The terms explain themselves, and are usually referred to as O.C. or R.C. for short. The Lentz demonstration gadget shown in the photographs, is of the oscillating cam type, and if you take a look at the view showing the inside, you can see at a glance how it operates. At each end of the cylinder there is a little separate steam-chest, from the bottom of which a passageway leads to the cylinder bore, in a manner somewhat similar to the passage from the port of a slide- or piston-valve cylinder. The entrance to this passageway is circular, and a double valve seat is formed on it, the valves being "double-edged," like that in a double-beat regulator valve. These valves are clearly shown in the picture, and need no explanation; the way they seat, entirely closing the passageways, can be seen

very plainly in the right-hand one shown in section. Each valve has a long grooved spindle, working in a guide, same as an internal combustion engine, and the end of each spindle is furnished with a roller. The spindles of the valves project right through the heads, and each carries a collar. A spring, housed in a removable pocket bolted to the end of the steam-chest, bears against the collar, and normally keeps the valve on its seating.

Baker, Stephenson link, or what-have-you, it doesn't matter a Continental. What *does* matter, is just this : that the valve-gear doesn't control the *amount* of port opening, same as it would if actuating a slide- or piston-valve. Instead, it controls *the length of time the port is open* ; the amount of port opening is constant, due to the action of the cam, as explained above. Now it is easy enough for the veriest Billy Muggins to see, that if the driver pushes his lever right forward

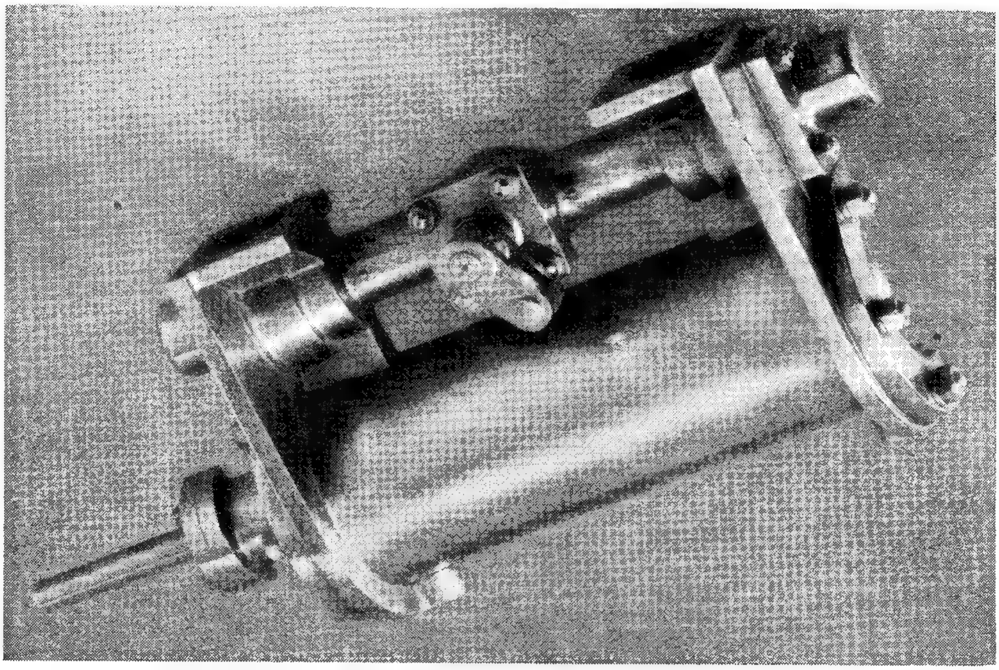


Photo by] [*L. J. Hibbert*

Oscillating cam type Lentz cylinder

Midway between the two steam chests, there is a cross shaft carrying a cam. This shaft is operated by a pendulum lever, like that on the Great Western valve gears ; and by waggling the pendulum lever, or rocking lever, back and forth, the raised part of the cam pushes each valve off its seating, in turn, thus admitting steam to the cylinder and letting it act on the piston in the usual way. Now if you take a look at the cam, you will see at once that it has a very abrupt inclination at each end ; and as soon as the inclined part comes in contact with the roller on the valve spindle, the valve is opened all-of-a-sudden-Peggy, to its full extent. Further movement of the cam doesn't move the valve ; it merely retains it in the wide-open position. When the movement of the cam is reversed, the valve still remains stationary, wide open, until the inclination of the cam reaches the roller, and then it flops down on the seating again, just as quickly as it went up, cutting off steam to the piston.

The rocking lever, or pendulum lever, is actuated by an ordinary valve gear ; Walschaerts, to the full-gear position, the rocking lever will be waggled back and forth to its fullest extent, maintaining the valves in the full open position for, say, 75 per cent. of the stroke ; just the same, in fact, as a piston- or slide-valve in full travel. When the driver notches up, the movement of the rocking lever is considerably reduced ; but whereas, with the ordinary piston- or slide-valve, this would mean reducing the port opening to little more than a crack, *the poppet valve is still flicked wide open.* It remains *wide* open for the same length of time that the piston- or slide-valve would be kept *partly* open, flopping down on its seating again at the desired cut-off point, 15 per cent. or more, according to what the driver reckons suitable for the load, speed, or grade. With a poppet-valve gear in good fettle, an earlier cut-off can be used than with a piston- or slide-valve ; the full port opening enables the steam to get into the cylinder quicker, and take effect, when the engine is running fast. By the same token, as Pat would remark, there is no need for the usual " lead " opening ; full pressure on the

piston as the crank passes the dead centre, is obtained by setting the gear so that the valve is flicked wide open at the critical point.

"Yes, but what about the exhaust; how does it get out?" say our beginner friends. That's an easy one! Alongside the steam chests, but separate from them, are two more exactly similar chests containing exactly similar valves, springs, and cams. The cams are operated from the same spindles, but their contours are so arranged that the valves flick wide open just before the piston reaches the end of the stroke, and remain wide open until the piston has nearly completed the return stroke, thus cutting back pressure to the minimum, and ensuring that there is nothing to retard the piston, and act against the steam pressing on the opposite side. The two "exhaust chests" are, of course, in direct communication with the blastpipe, same as the exhausts of a piston- or slide-valve cylinder.

The Rotary Cam Type

The *details* of a rotary cam gear differ from those of the oscillating cam; the valves are usually placed in separate cages, allowing the whole lot to be removed when the seatings need attention, and sometimes the valves are arranged vertically. However, the *principle* is the same. The difference in action is that the cam goes around, like the cams on the car engine; and this causes a bit of complication when it comes to providing a means of notching up, and reversing. The camshaft is driven by bevel gearing from the driving axle, so is necessarily in fixed relationship to the axle, as regards movement; whilst it is impossible to vary the valve opening on the cam itself, as its length must remain constant, being in one solid piece. The only thing to do, is to provide several cams of different lengths, and make the shaft slide, so that each of them may, in turn, be made to operate the valve spindle. This means that there can only be certain definite cut-off points, same as with an ordinary valve gear operated by a "pole" lever and quadrant; you only have the degrees of cut-off indicated by the notches, and nothing between. Special cams also have to be provided for reversing. This has been found in practice, to be a big disadvantage; one driver, for example, said that one cam cut off too early, and he couldn't keep time by using it, whilst if he dropped back to the next one, it nearly killed his fireman. This, and maintenance troubles, has been the cause of the removal of poppet valves from many engines. The original L.N.E.R. 2-8-2 *Cock o' the North* had poppet valves when first built; but after rebuilding, she had Walschaerts gear and piston-valves. Many L.N.E.R. engines have been similarly converted; what will happen to the L.M.S. engines remains to be seen. As it has been stated in print, that simplicity is to be a feature of the new standard British Railways locomotives, lion-and-wheel brand, it is a pretty safe bet that poppet valves won't feature in their make-up.

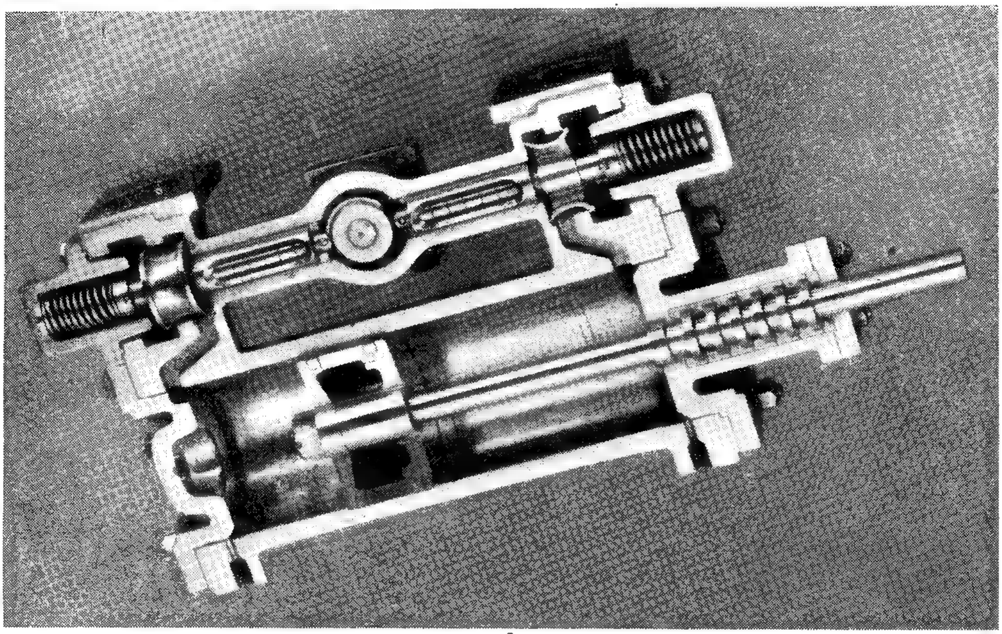


Photo by] [*L. J. Hibbert*

Section, showing how the valves operate

Before leaving the subject, I might mention that an infinitely-variable poppet valve gear was designed by a woman member of the Institution of Locomotive Engineers, Miss Verena Holmes. To the best of my knowledge and belief, she got hold of the idea from the action of a pair of

scissors ; the two rollers and the toggle levers looked exactly like the lower part of that useful feminine tool. It would take too much space here, to explain fully how the gear operated ; but by varying the distances between the rollers, which were connected to the valve spindle *via* the toggle, the time between the opening and closing of the valve could be varied in accordance. The gear was never tried on a locomotive, and I shouldn't be surprised to find that this was, in the main, due to the fact that it was designed by somebody who wore a skirt. I don't love the land beyond the Iron Curtain any more, nor any less, than the good folk who read these notes ; but if Olga or Sonia wants to drive a locomotive, and has the physical stamina, knowledge, and ability, there is nothing to prevent her handling the regulator, lever, and brake valve. British girls handle tractors, heavy lorries, and even tanks and caterpillars ; why not locomotives ? The answer is probably something to do with convention and prejudice, so we'll leave it at that.

Little Poppet Valve Cylinders

As I mentioned last week, the reason I have never described in full detail, the way to build a poppet-valve locomotive, was simply because nobody wanted it. Maybe, now I have simply explained and illustrated the valves, one or two of our experimentally-minded builders might care to have a shot ; although they won't get any better results than can be obtained with my ordinary piston- and slide-valve arrangements, it is "something different," anyway ! I would gladly give details of a poppet-valve cylinder which could be applied to any of the engines I have described in these notes, if sufficient readers were interested, and our friend the K.B.P. has no objection. Meantime, if anybody wants to do a little experimenting on their own account, the sectional illustration of the Jerry cylinder will show them how to do it. As it would be very difficult to get the double seating of the valves shown, to remain steamtight, even if you managed to get them O.K. at the first kick-off, the hollow bobbins could be replaced by an ordinary "mushroom" head, with a slightly bevelled edge closing down on the outer seating only. The recess behind the valve head need only be very shallow—if too big, there will be a waste of steam, as the recess has to be filled and emptied at every stroke—and plain drilled holes could be made from the edge of the bore, to the recess. There would be no need to provide any rollers on the ends of the valve spindles. Don't forget you would need four valves per cylinder ; two as shown, for steam admission, and two similar ones, in separate cavities, for the exhaust, the space behind the valves being connected to the passages. The exhaust springs would need to be strong enough to hold the valves against steam pressure, as the solid valves would be unbalanced ; or they could be turned around, to open against steam pressure. No alteration would be needed to the valve-gear ; merely connect the radius rod or valve rod to the rocking lever, and set the valves to start opening a shade before dead centre.

Miniature Slide and Strip Projectors

(*Continued from page* 918)

loosely, so that it is not liable to crack if the lamphouse warms up. The relief design on the escutcheon plate is, of course, optional, and the constructor may use his own device here, but it is expected that etched or cast plates with the "M.E." monogram will be available in due course. Details of the pivot screw for the escutcheon plate are shown with those of the latch components ; it has a thin, slightly raised head, and is shouldered to screw home, while allowing the escutcheon plate to swing freely. The hole for this screw should be tapped after the port frame and backing plate have been secured in position.

A suitable tool for cutting the 1 in. holes in the sheet metal wrapper and inner lining is an old-fashioned carpenter's centre-bit, which has a small pilot spike to pierce the centre hole and an annular chisel-edged cutter. When fitting the lining, the holes for the port screws should be "followed through," using a spacing piece of wood or other suitable material, and the port holes marked after the lining is temporarily secured. It will be seen that nuts are used as spacers between the backing plate and the lining, with locking screws to secure the lining on the inside, but other methods of spacing may be used, so long as the free flow of air is not impeded, and the minimum of surface presented for conducting heat to the outer wrapper.

It is quite likely that when the base and lamphouse are finally finished, a few chinks will be left where joints do not fit perfectly. These are most obtrusive in the lamphouse, where they may permit the escape of stray beams of light, but they are also objectionable in the base, and it is desirable to fill them, if only for assisting the building-up of smooth, flush surfaces. Any form of stopping which will withstand reasonable heat may be used, such as white lead, glazier's putty, plastic wood, etc., but a particularly durable stopping for lamphouse joints is metal cement, or the preparation known as "cold solder," which appears to be aluminium powder suspended in cellulose varnish. This will stand all the heat likely to be encountered, and is not liable to be dissolved or "lifted" by the enamel solvents afterwards.

(*To be continued*)

Novices' Corner

Machining Angle-Iron

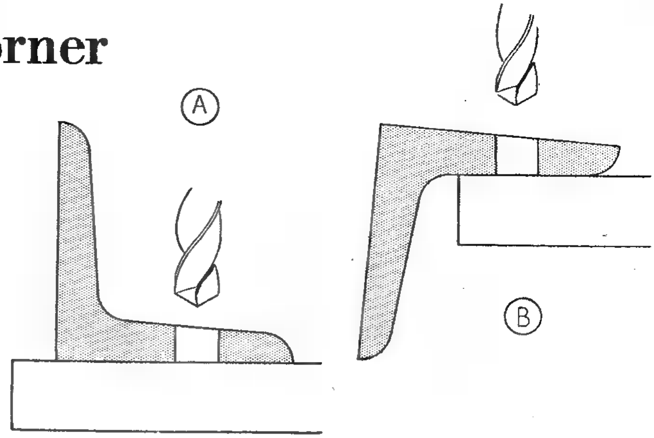


Fig. 2

ANGLE-iron had many uses in the workshop, but because of the shape in cross section to which much of this material is rolled, it presents many problems in machining.

Angle-iron is made in the two forms illustrated in Fig. 1, *A* and *B*. At *A* is shown a section of light angle-iron while at *B* the form usually given to heavy angle is illustrated. It will be observed that, whereas the outer faces of both forms of the material are roughly at right-angles to one another, the inner faces of the heavy angle-iron are out of square, and in addition the inner corner is well rounded.

The out-of-squareness of the inner faces renders angle-iron difficult to hold securely in the machine vice, and will result in holes drilled in the material not lying squarely with the outer faces. This is most noticeable when the work is mounted with the inner face resting upon the table of the drilling machine; moreover, the curvature of the corner, if allowed to foul the machine table, will also add to the inaccuracy of the machining.

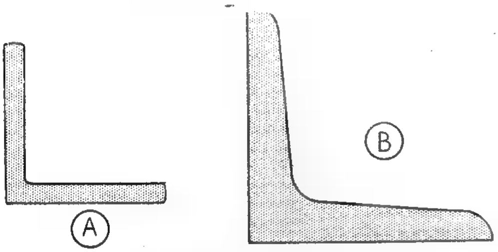


Fig. 1. *Two common forms of angle-iron*

These points may be of little moment where the holes are drilled with ample clearance to take bolts, although, even then, it is better to drill from the inner side of the angle, for not only is the area of metal in contact with the table greater, thus giving more stability to the work, but the drill will then be square with the outer face. Fig. 2 depicts the effect of drilling *A* from the inner side and *B* from the outer side of the material. Light angle-iron does not present these particular difficulties for both inner and outer faces are square, and it is, therefore, immaterial from which face the work is drilled.

When a piece of heavy angle material is to be used as a bracket to support a fitting it may be important that the machining should ensure that the part stands truly upright when mounted.

As an example, a 4 in. diameter gauge had to be fitted on an angle-bracket, and, to do so neatly, the angle-iron needed to be threaded $\frac{3}{4}$ in. $\times$ 26 t.p.i. to receive the screwed foot of the gauge, for, here, there was no shoulder on the gauge-nipple to form a bolting face, nor was the length of the threaded portion sufficient to allow the clamping nuts to be fitted. The work was, manifestly, too large to be undertaken in a small drilling machine; and, even if it had been possible to drill the necessary tapping hole in this way, the threading with a hand tap would, most likely, have been out of square.

The material was therefore filed to shape, and, after drilling two holes for bolting the bracket to the apparatus under construction, the centre for the $\frac{3}{4}$ in. $\times$ 26 t.p.i. hole was marked-out on the inner face, and the work was mounted in the 4-jaw independent chuck in the manner shown in Fig. 3. It will be seen that the bolting face of the angle-iron rested across one pair of jaws whilst the other pair were used to adjust the drilling centre. The work was firmly pressed against the face of the chuck when tightening the jaws, and this adjustment prevented the material from moving backwards when being drilled.

Angle-iron held in this way may easily be drilled and tapped from the tailstock, but the tapping in the lathe of a hole as large as $\frac{3}{4}$ in. diameter requires special machining methods that will be described later.

When circumstances permit, it is better to mount such work as has just been described upon an angle bracket bolted to the lathe faceplate, for by this means not only will it be possible to drill and face the side of the angle-iron that is directly towards the tool, but the reverse face may be machined if a tool specially made for the

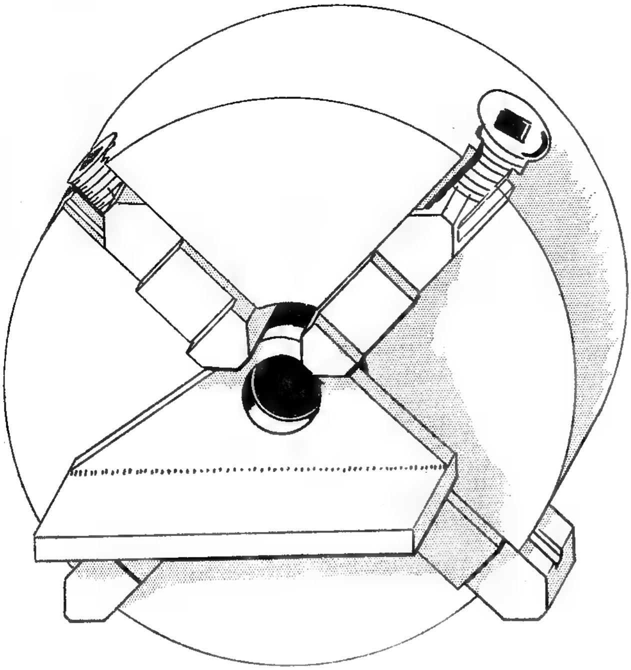


Fig. 3. Mounting angle-iron in the 4-jaw chuck for drilling

purpose is employed. This tool is called a back-facing tool, and is described in *Lathe and Shaping Machine Tools*, published by Percival Marshall & Co. Ltd.

It is essential to machine the nut adjustment face on the inner surface of heavy angle-iron, otherwise bolts that may otherwise have been accurately fitted will be pulled out of line, and may even be bent. Instead of the back-facing operation referred to, the adjustment face for smaller nuts can be machined by spot-facing in the drilling machine. Spot-facing cutters have two or four cutting edges, and are provided with a pilot pin to enter the drilled hole and so keep the cutter from wandering away from the work. A typical example is shown in Fig. 4. Commercially made spot-face cutters are sometimes fitted with removable and interchangeable guide-pins, and also with interchangeable cutters that can be mounted on a common arbor. It is, however, a very simple matter to make these tools for oneself, and full instructions have been given in *The Amateurs' Workshop* and in *In the Workshop*, Vol. 1, both published by Percival Marshall & Co.

It must be emphasised, however, that the surface to be spot-faced needs to be cleaned up by filing or the hard scale on the material will quickly blunt the cutting edges of the tool.

Although, as its name implies, angle material was formerly made from iron, nowadays it is largely manufactured mild-steel in order to improve its strength and machinability.

Nevertheless, some grades of angle-iron will be found difficult to machine to a good finish owing to the precise character of the metal ; it is advisable therefore to run spot-facing cutters at a slow speed to avoid blunting the cutting edges.

Making a Small Angle-plate

The ordinary commercial form of angle-plate will often be found too large for securing small work to the lathe saddle, particularly when the angle-plate itself must be low enough to pass under a cutter or boring bar mounted in the lathe.

Messrs. Myford Lathes, recently introduced some small angle-plates designed for this purpose, but these low angle-plates can be readily made from angle-iron when needed for any particular piece of work, and in time a range of these useful fittings may well be accumulated sufficient for all ordinary work.

As has already been mentioned, the outer faces of the material are not always at right-angles to one another ; these surfaces must therefore be converted by machining in the lathe. To do this, an ordinary angle-plate is bolted to the lathe faceplate to carry the length of angle-iron and the work is then fitted in place with its vertical faces set squarely outwards by placing a ruler, or any parallel strip of metal, between the inner faces of the material and the faceplate. When an angle-plate is being used in this way, a counter weight must be attached to the faceplate to balance the parts. Slip the belt off the mandrel pulley and spin the faceplate ; if the balance is correct the faceplate will not tend to stop in any particular place.

The work can now be faced in the ordinary way, using a fine feed and taking only light cuts.

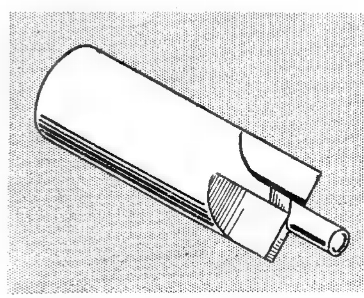


Fig. 3. A spot-face cutter

The face of the other limb of the angle is next machined in the same way. It now remains to face the inner surfaces of the work to form true bolting faces for the clamping nuts that will later be used to secure the angle-plate to the lathe saddle.

Where the angle-iron is of the form illustrated in Fig. 1 *A*, the bolting faces can quite well be made flat, but a machining operation is really preferable to correct sloping surfaces indicated in Fig. *B*. There is, of course, no need to machine

the whole of these surfaces for they need to be true and flat only where the nuts bear.

Fig. 5 shows a small angle-plate made for a special purpose, and, here it will be seen that the horizontal surface has been filed flat to accommodate the T-bolt used to secure the fitting to the lathe saddle. However, the inner face of vertical surface has been machined in order to ensure that it is truly parallel with the outer surface. This machining was carried out with the work bolted to an angle-plate attached to the lathe faceplate. One bolt hole was set to run truly, and a facing cut was then taken to form ■ circular flat area; the work was then reset and the other bolting face was machined.

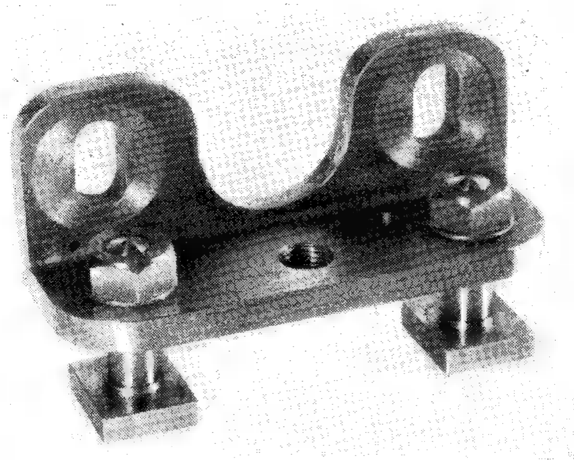


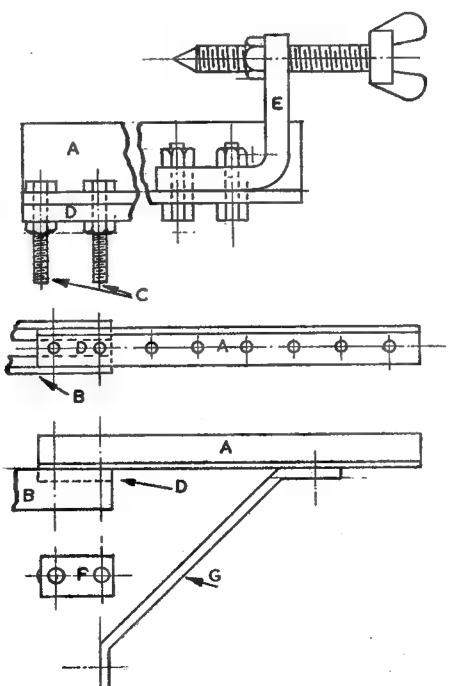
Fig. 5. An angle-plate with faced and slotted inner surface

It will be seen that the bolt holes have been filed out to form slots so that the position of any work attached to the fitting can be adjusted.

Moreover, the circle of the machine bolting face has been made large enough to allow the clamping nuts to seat truly at either end of the slope.

A Lathe Bed Extension

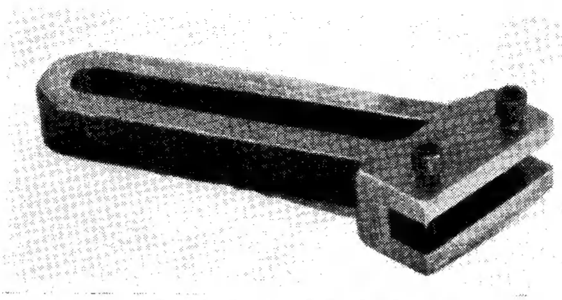
A USEFUL addition to a short bed lathe, so that long articles such as table legs, etc., can be turned, consists of a piece of angle-iron, say, 2 ft. 6 in. long, at least $1\frac{1}{2}$ in. × $1\frac{1}{2}$ in. × $\frac{1}{4}$ in.; if for a big lathe it can be heavier section (*A*). This is bolted to the lathe bed (*B*) by means of two (for ■ small 3- or 4-in. lathe) $\frac{3}{8}$ in. bolts shown at (*C*). A distance-piece (*D*) to fit the slot in the bed, is put in place, held by the same bolts. A new tailstock (*E*) is made of ■ piece of iron, or mild-steel, at least 1 in. × $\frac{1}{2}$ in. It is well heated, and bent at right-angles, the height to suit your lathe centres. A $\frac{1}{2}$ in. mild-steel bolt fitted with ■ wing-nut is tapped into it; it is then turned to centre point and case-hardened. The wing-nut can be secured with a thin lock-nut, or pinned through. This tailstock is bolted to the extended bed by means of two $\frac{3}{8}$ in. bolts, the bed being drilled $\frac{3}{8}$ in. clear holes, say every 2 in. If this is to be in constant use it will pay to slot the angle instead of simply drilling holes in it. A plate (*F*) is fitted under the bed to suit the bolts (*C*). If a long angle is fitted it can be supported by means of ■ stay (*G*), bolted to the angle bed, and lathe standard, or the floor. The ordinary hand rest can be used bolted under the angle bed, though ■ longer T may be required. — R. F. M. WOODFORDE.



Extension Tool-Holder for Lathe Work

by F. Butler

THE lathe tool-holder shown in the photograph was constructed to deal with the machining of awkward and unwieldy jobs which, either because of their shape or size could not be finished by using the standard range of turning and boring tools. In such cases it is usually found that the top-slide or toolpost fouls the work, or the cross-slide cannot be backed away sufficiently to machine jobs which are so big that they require the full swing of the lathe. For instance, it is quite a problem to cut the grooves in a large vee-pulley, or to bore a small hole in the centre of a chucked casting with projecting lugs and bosses, unless the slide-rest tools have a pronounced and dangerous overhang.



The lathe tool-holder complete

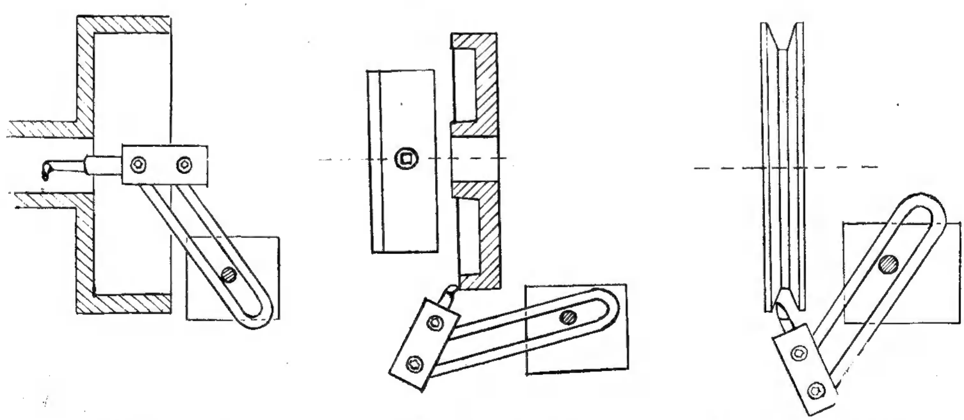
The component consists of a U-shaped mild-steel shank, bent up from a 12 in. length of ½ in. × 1 in. black bar. This is arc-welded to a 2½ in. length of 1¼ in. square bar, which has a ½ in. square slot milled along its length to accommodate the tools. Two Allen set-screws ($\frac{5}{16}$ in. B.S.F.) are used to clamp in position the cutter-bits, but four tapped holes are provided, two at the top and two underneath the cutter-head, which can be turned over to alter its angle of attack on the work. The head is welded on to the shank at an oblique angle for this reason.

The distance between the arms of the shank is big enough to allow the tool-holder to slip over the normal tool-post clamping-bolt. Packing strips underneath it lift the tool edge up to centre height.

Aside from the slot-milling operation, the only other machining required is facing the clamping surfaces, which is easily undertaken with the job held in the 4-jaw chuck.

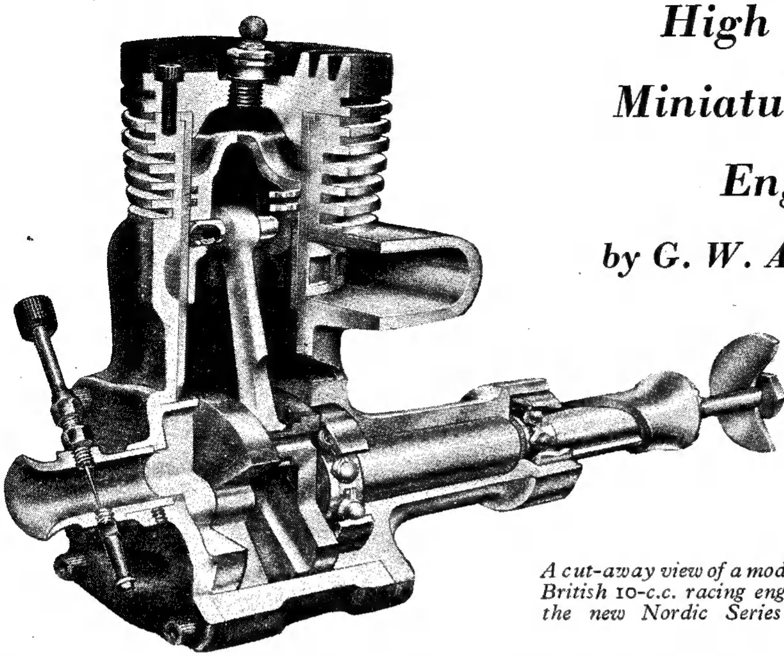
The sizes given are suitable for a 6-in. lathe, but they can easily be scaled down for smaller lathes, while still keeping sufficient rigidity for all normal work.

The sketches show a few examples of operations which are easily undertaken using this accessory, which has proved surprisingly useful and has well repaid the small effort involved in making it.



Deep boring — *Back surfacing* — *Cutting vee groove*

Typical operations, using the extension tool-holder



High Output Miniature Racing Engines

by G. W. Arthur-Brand

A cut-away view of a modern British 10-c.c. racing engine, the new Nordic Series II

UNINITIATED readers are frequently quite genuinely astonished at the tremendous output of modern 10 c.c. two-stroke racing engines. The mere idea of over $1\frac{1}{4}$ b.h.p. emanating from so small and light a piece of mechanism is astounding, to say the least, and they are apt to be led up the proverbial creek by well-meaning individuals who consistently refuse to make themselves familiar with the fact that they are as clueless as the unfortunate characters on the receiving end of their endeavours to throw light upon a subject on which they are, themselves, in the dark.

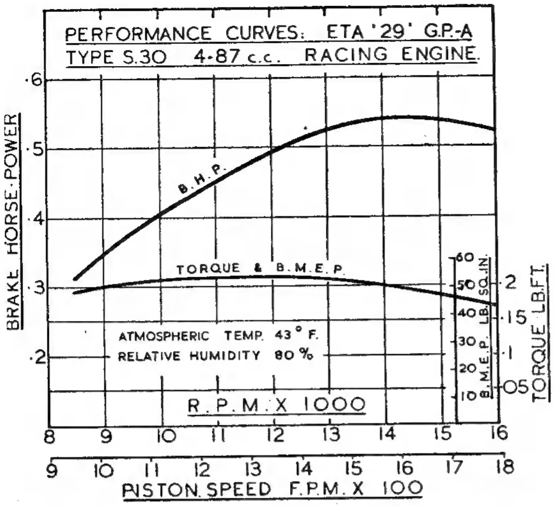
Only a few nights ago I was checking over one of the early-type miniature petrol motors, and I could not resist the temptation to smile as I observed and thought over the many, to us now, so obvious developments which have taken place in more recent years. The engine was designed about 1939, and was fitted with rotary disc induction, flat-top cast-iron piston and plain cast-iron crankshaft bearings. The compression was very mediocre, about 7 : 1 and the transfer passage was barely big enough for a flea to crawl through without its whiskers touching. Yet in those days, as well as to a few unenlightened souls today, this engine was considered a sort of super development in the miniature i.c. engine world, even though its b.h.p. output was quite infinitesimal when compared with modern practice.

We have now arrived at a state in which relatively small differences in design and maintenance have a considerable effect upon performance. The maximum output of an engine is achieved by bringing to bear the highest mean pressure on the piston multiplied by the largest number of firing strokes, i.e. " punch " + r.p.m. The essential factor in obtaining " punch " is the complete filling of the cylinder with fuel mixture, to be compressed under the optimum usable compression ratio.

In order to raise the rate of r.p.m. other problems are encountered, not the least of which is the fact that incoming gas can only be induced into the cylinder by means of difference in pressure, and gas, like all other things having mass, is alergic to being stopped and started too rapidly! Another factor which offers continued opposition to the attainment of high r.p.m. is that the inertia stresses go up as the square of the increase of revolution rate. This means that should it be desired to double the engine speed, it will have to be borne in mind that the inertia loads will be fourfold. These greatly increased inertia loads in turn have their influence on that very important factor at high speed, friction.

The exhausting of the burnt gasses is a quite simple matter, that is relatively, as the pumping action of the piston readily performs this task, provided the porting is of adequate area. It will be appreciated, therefore, that if the b.m.e.p. could be doubled, at the same time keeping the revolution rate constant, this form of power-inducement would be fraught with fewer hazards than by trying to obtain power by increasing the r.p.m. Since however, this scheme has been, to date, proved impracticable for our purpose, we will have to be content to pursue the attainment of optimum b.m.e.p. at optimum r.p.m.

To charge the cylinder, it is necessary to provide a type of passage into the port which is smooth, free from protrusions and sharp bends, and of the correct cross-sectional area to give the most suitable gas velocity. The porting must offer as



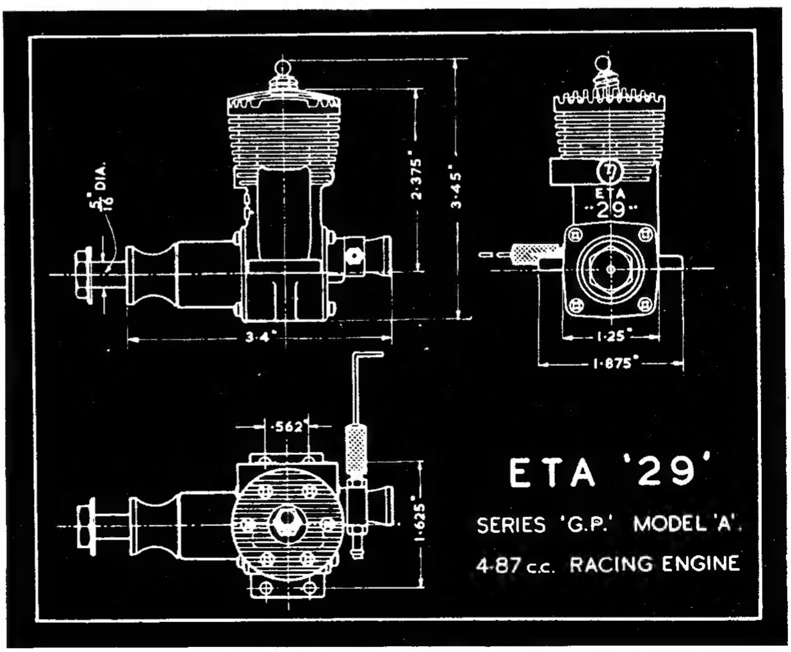
little obstruction as possible and be of such area as to allow opening for the correct length of time. The culmination of correct application of these points will be a highly beneficial supercharging effect over a certain range of r.p.m. as a result of ram-effect in the induction pipe.

It is an annoying tendency, even with a number of well-tried racing fuels, especially of the nitrated variety, to detonate and so detract from performance long before the most useful compression ratio has been attained. By employing aluminium alloy for the pistons and heads of modern racing engines, both miniature and full-size, designers have been able to increase thermal conductivity to a point where premature detonation has been considerably reduced. This may be attributed to resultant lowering of charge temtures, together with those of the areas with which contact is made by the charge on entering the combustion chamber. It must be realised that the very volatile fuels used in racing engines tend to absorb heat from the engine with great rapidity and, as the temperature of the charge after compression is a function of its temperature before compression, it is obvious that in order to get maximum power we should ensure that as little heat is imparted to the charge as possible. In cases where straight methanol + castor oil fuels are used, charge temperatures tend to be at their lowest as a result of the great cooling effect of the alcohol content.

Needle angle and jet orifice play an important part in miniature racing engine design, as it becomes necessary, due to lack of any form of manual regulation under operational load, to effect a setting which will allow a smooth application of torque and a steady build up in r.p.m. to maximum output. Another important factor is the weight of reciprocating parts. Should the piston and connecting-rod be too light, they will fall down under the heat and load ; should they be too heavy, they will detract from performance by placing heavy loads on the bearings and reducing acceleration due to the increased inertia of the parts that have to be accelerated. When designing pistons it must not be forgotten that, not only must the functional stresses be taken into account, but also the temperature at which it might reasonably be expected to operate, since heat greatly reduces the strength of the material under working conditions.

It is the writer's opinion that rings could be considerably reduced in thickness, it having been found that narrow ones of high pressure tend to flutter far less at high r.p.m. than those of the deeper variety.

Lastly, the placing of the plug for best performance. It may be said here that this point is of far greater importance than the majority of readers are likely to realise, especially in



connection with high b.m.e.p. and smooth running. On a well designed motor, the spark will occur over that part of the combustion chamber which possesses the greatest volume, so that as the explosion takes place the " push " impinging on the crown of the piston starts, in effect, in the deepest portion of the chamber, spreading evenly to the tapered upper surfaces.

NOTE.—*In fairness to those of you who possess and run engines of the " older " variety, I must stress that it has not been my intention in writing these notes to boost the modern high-performance engine to the detriment or exclusion of the more popular " petrol " type which have done and are still doing, so much to forward the cause of the i.c.-engine-propelled miniature in its many and varied forms. It has merely been my purpose to answer, in as concise a form as possible with limited space, some of the many queries I receive from time to time and more especially those which I considered would be of general interest.*

CLUB ANNOUNCEMENTS

Preston and District Society of Model Engineers

It has been decided to hold the second models exhibition of the society on August 31st, September 1st and 2nd, in the Assembly Room of the Harris Institute Technical College, Corporation Street, Preston. The principal of the college has kindly consented to let the society hire this room for the occasion.

Model engineers, especially the " lone wolves " in the district, are asked to communicate with the secretary if they wish to support this exhibition. A cordial invitation is extended to all clubs and societies in the north-west for the loan of models, and it is hoped that they will be able to pay the exhibition a visit.

Those intending to show their models are asked to send full particulars to the secretary, giving a full description overall dimensions, weight and value. At the same time information as to where the model or models can be collected, when the time comes, will be needed as well.

Society meetings are held every other Friday at 23, Chapel Walks, Preston, at 7.30 p.m. The next two meetings will be held on June 30th and July 14th.

Hon. Secretary: M. A. COLLARD, 46, Brackenbury Street, Preston.

Merseyside L.S. & M.E.

On Sunday, May 21st, a coach party spent an enjoyable day at the Bolton track. The club's temporary track in Calderstones Park has been scaled and painted, and will shortly be in regular use. The official opening date will be announced later. Meanwhile, the members continue to hold regular meetings in the clubroom, 12, Shaw Street, on alternate Wednesdays, at 8 p.m.

Particulars of membership from the Hon. Secretary, A. F. DUCKITT, 145, Bowring Park Avenue, Liverpool, 16. Huyton 2552.

North Devon Society of Model Engineers

A very interesting evening was spent on May 12th when films from British Railways, the E.D.A. and South African Railways were shown.

Mr. Harman gave a very interesting lecture recently on " Tool Steels and Lathe Tools," followed by Mr. G. T. Bainbridge who gave a description of his visit to Toronto and the Toronto Model Engineering Society, which his son, Mr. C. G. Bainbridge, has now joined since he took up residence in Canada.

Forthcoming meetings are :—

June 28th. Sheet metal work, demonstration by Mr. H. Prince.

July 12th. Progress report, " bits and pieces " meeting. Bring along that unfinished model, or bits thereof.

July 26th. Talk by British Railways engineer on " The West Country Locomotive."

Railway track at Pottington Field, Barnstaple. Come and drive a locomotive—engines are running every Saturday afternoon, weather permitting. All are welcome.

Hon. Secretary: J. E. P. HUTCHINSON, 8, Clinton Terrace, Barnstaple.

Southport Model and Engineering Club

There has been a secretarial change in the above club, and the new Hon. Secretary's name and address is THOMAS NELSON, 41, Hawkshead Street, Southport. Tel.: Southport 3843.

Eastbourne Society of Model Engineers

On Saturday, May 13th, Mr. Penzer, who is a keen member of the society, entertained most other members to a locomotive party at his residence at Hampden Park. The weather was ideal, and steam having been raised, the first locomotive, a 3½-in. gauge Northern Atlantic owned by Mr. Penzer, did several laps of the continuous track, which was situated under the fruit trees in the garden. Steam was then raised in other members' locomotives, which included two " Juliet's," one L.N.E. 4-4-0, one 0-6-0, and a South Western 4-4-0. These " did their stuff " to the satisfaction of all concerned. Thirsty enginemen and spectators partook of the excellent tea and cakes which were served by Mrs. Penzer, and running was carried on until dusk. Votes of thanks to Mr. and Mrs. Penzer were proposed and carried unanimously which rounded off a very pleasant and successful social event.

Hon. Secretary: C. T. UPTON, 13, Lawns Avenue, Eastbourne.

Huddersfield Society of Model Engineers

An open day will be held at Highfield on July 8th, 1950, for locomotives and boating. Clubs invited.

July 17th to August 19th, 1950. " Holidays at Home." Greenhead Park. Locomotives running.

Exhibition in The Drill Hall, Huddersfield, October 17th to 21st, 1950.

Hon. Secretary: F. W. L. BOTTOMLEY, 763, Manchester Road, Huddersfield.

Torbay Society of Model Engineers

The above society are holding an exhibition from June 28th to July 8th, 1950, 10.30 a.m. to 10 p.m., at Abbey Road Congregational Hall, Torquay. This year we have the loan of the British Railway Executive model layout for the first time in Torquay, and we are the first model engineers ever to have the loan of same. We hope to have the opening ceremony broadcast in the West of England news on June 28th, by the deputy mayor and mayoress. A special cheap day ticket is being issued in the Western Region for the show by British Railways.

We extend a warm welcome to all model engineers who are, or will be, on holiday in Torquay between these dates.

Hon. Secretary: W. A. SOUTHAM, Mount Cottage, Upper Braddons Hill Road, Torquay.

Hayes and Harlington Model Engineers Society

Owing to the sudden death recently of Mr. Baines, the society's secretary, a change has had to be made to fill this office. The new Hon. Secretary is now A. G. HOLDING, 17, Widmore Road, Hillingdon Heath, Uxbridge, Middx.

The Bradford and District Model Car Club

The above club are holding an open event on Sunday, July 2nd, 1950, on the new track at Yeadon aerodrome, near Bradford.

The track will be open for practice from 10 a.m. to 1 p.m., and racing to commence at 2 p.m. prompt. Entrance fee, 2s. per car.

Refreshments will be provided at reasonable charges in aerodrome restaurant, and all other club members, and lone hands, are welcome.

Hon. Secretary: JOHN S. MOORE, 48, Pollard Lane, Undercliffe, Bradford. Tel.: Bradford 38073.

Ickenham and District Society of Model Engineers

The above society has had a very successful auction sale, which caused much amusement and brought in a substantial figure to the coffers. Through the generosity of various members in giving tools and materials which were sold at small price, it has enabled several of our younger members to start seriously in the realms of model engineering. It is proposed to devote several meetings to getting the society's track ready for the forthcoming exhibition.

Visitors are always welcome at the Memorial Hall, opposite the " Fox and Geese," Ickenham, every Friday, at 7.30 p.m.

Hon. Secretary: A. F. DUNN, 27, Ivyhouse Road, Ickenham, Uxbridge, Middx.